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MONTHLY

FEBRUARY

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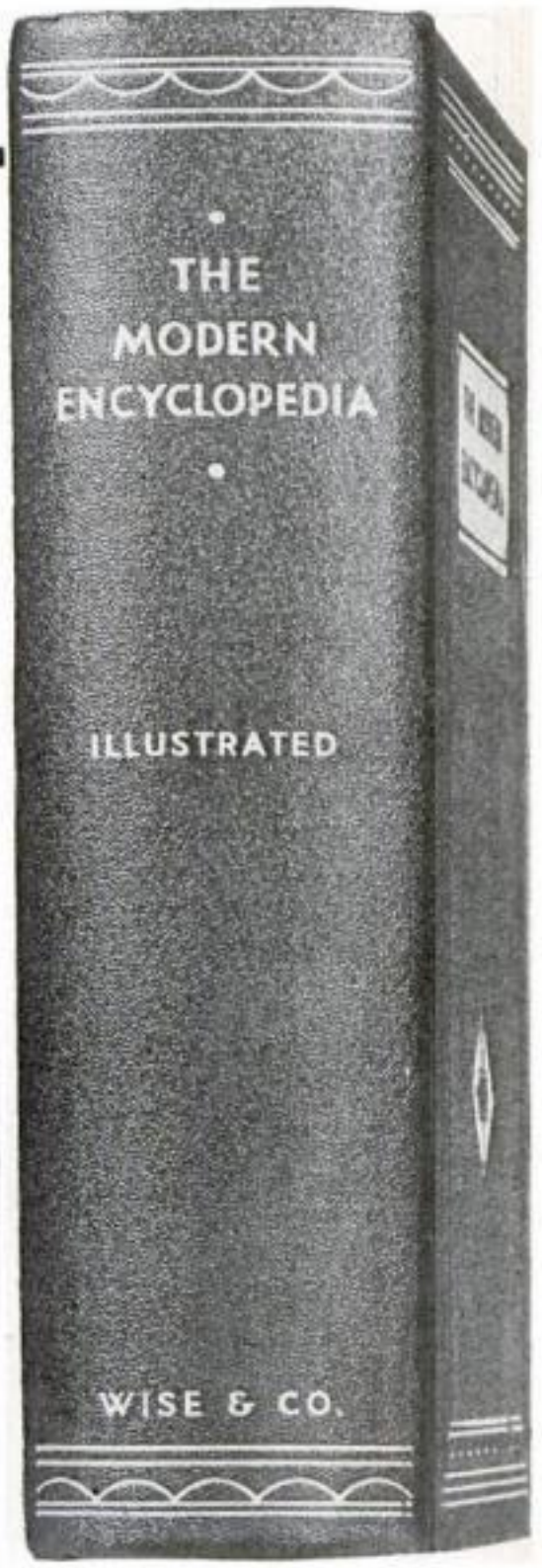

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FEATURES AND DEPARTMENTS

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POPULAR SCIENCE MONTHLY FOR FEBRUARY, 1934

In This Issue—Hundreds of Fascinating Articles Tell the Latest News of Laboratory Discoveries, Scientific Triumphs, and Amazing New Inventions

What is a Good Microscope Worth?

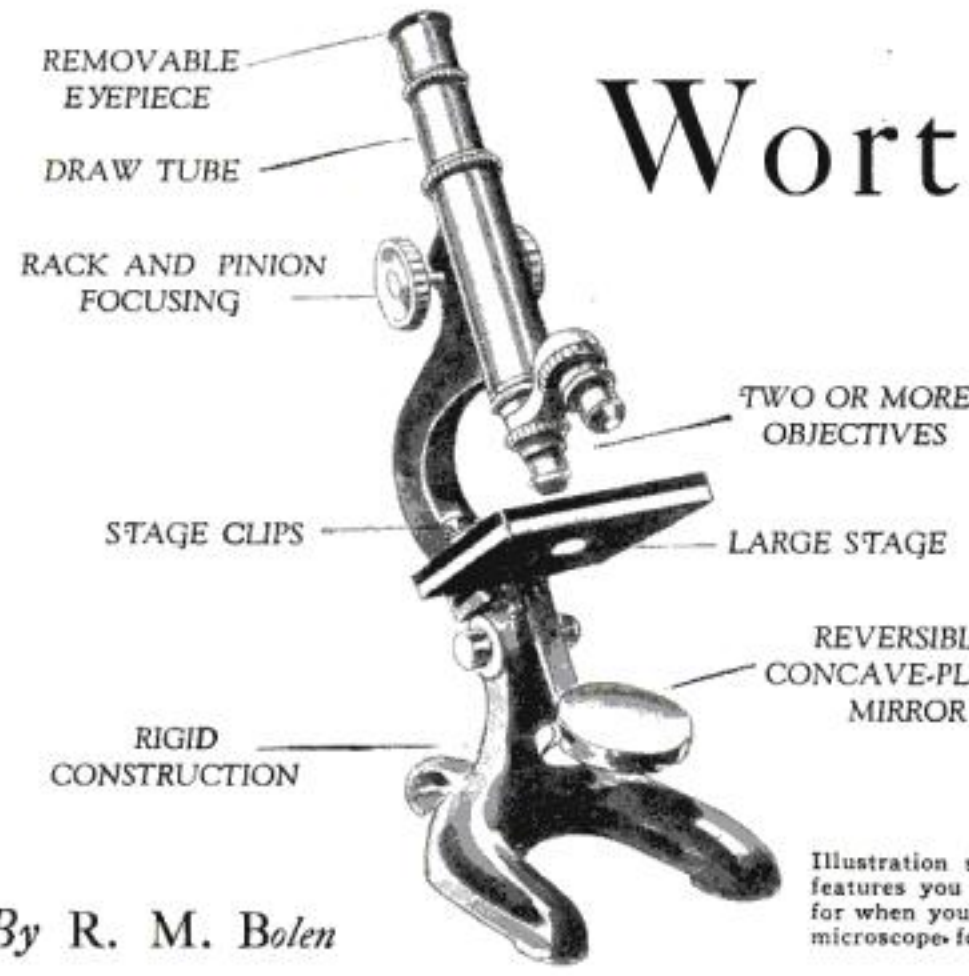

Illustration showing the features you should look for when you select your microscope for home use

By R. M. Bolen

ANY hobby requires good tools and microscopy is no exception.

To get the most out of the thrilling scenes in that ever-changing world beyond your sight, you must own a good microscope. Its lenses are your passport into unseen lands and unless they give a clear view your travels soon will lose their zest.

When you buy your microscope, you will be taking the most important step of your career as a microscopist. Unlike the experienced professional who can spend thousands of dollars, you will be an amateur striving to make a choice between low-priced instruments. Naturally, your inexperienced eye may fail to see the difference in value between one microscope costing a few dollars and another selling for twenty.

The amateur must realize first of all that a microscope is a scientific instrument. Unfortunately, the present popularity of amateur microscopy has brought a group of extremely low-priced and unscientific microscopes into the field. As toys, they fill a definite need. But to the newcomer, who is serious about his microscopy, they often spell disappointment.

A good microscope is an accurate optical device. It must be made of the best materials under precise conditions. Lenses that are to enlarge tiny organisms must be carefully ground and polished. In many of the cheaper microscopes, the lenses are crude affairs, merely pressed or roughly ground to shape and barely polished enough to remove even the small scratches and imperfections that are bound to exist. Such lenses can never give the clearness and definition of a good optic. Instead, their fields will be spotted with dirtlike specks that will move as the eyepiece is rotated.

To be accurate, a microscope must have a line of sight that passes through the exact centers of all its lenses. Any other path results in distortion. This degree of precision can be obtained only by manufacturers who are equipped for delicate work. The building of a microscope is a job for an optical expert and not a manufacturer of toys.

The general appearance of a microscope should be that of a high-quality instrument. It should have a durable finish and be easy to clean, stable, and sturdy. Since adjustments must be made while the microscope is in use, its frame should be rigid enough to prevent the field of vision from wandering at the slightest touch. There should be some kind of focusing arrangement—a rack and pinion has been found by professionals to be the best, and a roomy observation stage fitted with strong spring clips to grip the ends of the specimen slides. One of the common deficiencies of cheap microscope is a miniature stage, far too small to accommodate the standard slides.

By examining the reflecting mirror below the stage of a microscope, the inexperienced amateur can tell a great deal about the quality *(Continued on page 5)*

WHAT IS A GOOD MICROSCOPE WORTH?

(Continued from page 4)

of the instrument. To do its work, it should be arranged so that it can be tilted at any angle. Many of the cheaper instruments have stationary mirrors that are entirely unsatisfactory. Also, to give the maximum of light, the mirror surface should be concave (curved in) to focus or concentrate the light on the object. A flat mirror merely reflects the light, spreading it over a large area.

It is in the question of magnification that the amateur is tempted to go astray in his choice. In his desire to get the greatest magnification for the least money, he often buys an instrument that sacrifices clearness. If the image is clear and well defined, a magnification of 200 or 300 is adequate for most work. In fact, many amateurs prefer to work at still lower powers. Of course, the ideal instrument is one that has two objectives or some other arrangement, like a sliding draw tube, for changing the magnification.

Do not be misled by the statements of power and magnification given in the literature and advertisements of some manufacturers. In accurate scientific work, magnification should be stated as *linear magnification* and not as area or volume magnification. A linear magnification of one hundred means that a line one hundredth of a millimeter in length appears one millimeter long. In area magnification, a false impression is created by squaring the dimensions to give area and in volume magnification, which is still more erroneous, the linear dimension is multiplied by itself three times.

When selecting one microscope from a group, be sure that the linear magnification in each case is given. Then compare the quality of each image. A microscope that magnifies only seventy-five times but gives a clear, clean-cut image is far better than another whose cheap lenses magnify 200 times to give a hazy, distorted view.

Many manufacturers also attempt to convey the impression that such an instrument as a cheap telescope can be used as a microscope. This is incorrect. The eyepieces of some telescopes can be used as low-power magnifying glasses but never as microscopes.

Like automobiles, tools, or fishing rods, a microscope is an investment. If you are choosing microscopy as a hobby, you will save in the long run by buying a good microscope with good lenses. You need not spend a fortune, good microscopes are sold at low prices. But before buying one, make sure that it has the features of a good instrument built into it by a manufacturer that has a good reputation in the field of optics.

Microscopy Articles

TURN to page thirty-six and you will find an interesting article telling how the amateur can examine the tiny wonders of the sea through his microscope. This is only one article in a long series, describing the thrilling experiments that can be performed by the amateur microscopist.

. . . Little Stories of PROGRESS—and those who make it . . .

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Asleep... *as his plane soared* OVER THE OCEAN

THIS story is more than "news" now—it's history. Schoolboys can tell you about gallant Wiley Post and his record-breaking solo flight around the world. But everyone doesn't know about the mechanical hand that guided him safely over the perils of the ocean *as he slept.*

Of course, some have heard of it before. They've seen pictures in the papers of a mechanical man—with electric bulbs for eyes and gears for teeth—who has just answered 100 questions or done 16 successive jobs in obedience to some human commands.

You men who read Popular Science Monthly because your interests make it necessary for you to keep step with industrial progress, know a good deal more about mechanical robots than that.

Among you are men who have already put such machines to work—quietly—without benefit of ocean flights or iron-clad "Frankensteins"—and with results which are written in profits rather than in newspaper headlines.

Readers of Popular Science Monthly had plenty of opportunity to determine the commercial possibilities of the robot. Back in 1929 we reported its efficiency in regulating traffic on one of the world's most crowded avenues. Since that day we have followed its progress—as other men found other uses. They made it flood airports with light at the sound of an approaching plane, operate power sub-stations, guide ocean liners on their course, set railway signals, sort textile fabrics, vend merchandise, run machinery in factories.

The robot is "all in a day's work" where this magazine is concerned. It is just another triumph of industrial science—one of the thousands we have printed—and will continue to print for men who seek in these columns the announcement of some invention or new material that can be applied to their business. Something they may find today, in these pages—or next month—or next year.

And if that new discovery or that new process does come, it is here that it will appear first. For Popular Science is the news monthly of Progress, and thousands of men like you rely upon it for the first reports of ways in which new scientific advancements can aid you . . . can help you keep one step ahead of the world.

Complete Construction Kit FOR A *Clipper Ship* Model

EVERYTHING you need to make a beautiful little miniature model of the famous American clipper *Sea Witch* is contained in a construction kit offered by the Popular Science Homecraft Guild. Unlike all previous clipper ship models, this one has been so greatly simplified that anyone can build it. Indeed, it is what is called a "pocketknife" model because so much of the work can be done with a penknife and a few single-edged razor blades.

The hull of the model is 9½ in. long, but the over-all length is 13 in., and it stands 8 in. high. The kit contains the hull carefully sawed to shape by hand from accurate master templates; half a dozen pieces of pine cut to approximate sizes for the deck fittings and boats; hardwood for the keel, stem, sternpost, rudder, and other parts; three sizes of round stock for the masts and spars; fiber for crosstrees and caps; thin hand-dyed linen rigging cord of the finest quality; thread, small chain, beads, fine wire, casein glue—in fact everything but the paint.

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Our Readers Say

Probably You Won't Agree With This List of Our Best

THAT college professor who picked the ten most interesting books written last year got me sharpening my pencil and thumbing over my back numbers of POPULAR SCIENCE MONTHLY. Here's my list of the ten most interesting (to me) articles you printed in 1933: Wild Horses Stampede for Movies, (Jan.); Hobbies of Great Surgeons, (Nov.); First Transatlantic Airline, (Feb.); Our Police of the Sea, (Jan.); Midget Sub to Seek Riches on Sea's Floor, (Mar.); Inside a Flaming Volcano, (Apr.); Missing! (Aug.); Midget Gardens, (Jul.); Animal Movie Actors, (Sept.), and Chinchilla Farms, (Dec.). Living in the country may have influenced me in selecting the animal and farm stories. Other readers may think I'm "all wet." If they do, let's hear from them and see what their lists will be!—R. A., Columbus, O. (R. F. D.)

Fumes to Kill Barnacles Released by His Paint

I NOTED with interest your article on barnacles. I have been hoping to make a barnacle-proof paint but as long as I followed the old ideas I have failed. Having lived around the salt water for nearly sixty years, I know something about it, especially as I made a study of barnacles and sea growth. Prof. Fisher's theory that the barnacle spawn can see and is attracted or repelled by different colors is probably wrong. Paints, either above or below water, reflect or absorb light rays. Also there must be a radiation or emanation of light energy in response to the light rays. White having the greatest radiation would tend to reflect more light energy. Those radiations perhaps could be felt by the barnacle embryo. My theory is that any paint, to be non-fouling, must give off gas.—C. E. P., Milford, Conn.

Even Air Travelers May Fail To Escape the Billboards

WHILE the art of flying as a family pastime is yet young, the various state governments ought to get busy and pass legislation against air-lane billboards. Our roads have been cluttered with thousands of square feet of advertising ballyhoo and now it looks as though they are going to confiscate our roads and fields as well to tell the story to airplane pilots. Already a gasoline company has built a civilian airplane service station near my home, and advertises the fact in twelve-foot letters that tell the current price of gasoline as well as the name of the station. With airplane tourists as well as automobile travelers, it looks as though our country is doomed to be one large billboard unless we get busy. —J. K., Hempstead, L. I., N. Y.

How to Land Planes Is What This Reader Wants to Know

I JUST finished reading an article about a Denver, Colo., inventor who has invented a merry-go-round apparatus for launching airplanes. His hicky may be O.K. for launching planes but I wish he, or someone, would please explain what good it is when it comes to landing a plane. If it does away with the long runway, how can a plane land there and if the runway is there for the plane to land on, what benefit would it be to erect an apparatus like that that would probably cost a lot of money when the plane could take-off from the landing runway? It seems to me that, if the pilot should try to land or hook onto this merry-go-round, he would be liable to crack up unless it is fixed so it can be put in motion like the trapeze on dirigibles that pilots hook onto. I wish somebody would explain the benefits of such an outfit as this merry-go-round. Maybe I'm just dumb and can't see into it.—L. L., Tallahassee, Fla.

Newton's Law Blamed for the Kick in a Gun

IN ANSWER to H. G., of New York, N. Y., as to what causes the kick of a gun, I would say that at the instant the explosion takes place in the chamber it exerts an equal pressure in all directions. The resulting force is applied to the gun equally in all directions except in the direction of the open barrel, in which direction the only force that can be applied must be through the friction of the bullet and the moving gas against the inside of the barrel. Since this is not great enough to balance the force upon the gun in the opposite direction, the gun tends to move backward or kick. To be more scientific, we can explain the fact by Newton's third law of motion, which states that whenever a body acquires momentum, some other body always acquires an equal and opposite momentum, (defining momentum as the product of mass and velocity of the body). Thus the gun would kick even if it could be fired in a vacuum or if a blank cartridge were used.—H. J. B., Greenville, Pa.

When Longer Words Are Found, He'll Find Them

E. F. K. at Elmira, N. Y., says he can't quite imagine a name longer than the one he gave the town in Wales which contains fifty-eight letters. There is a Finnish word of one hundred and three letters, meaning "to bow," which looks like this: KUMARREKSITUTEESKENTELEENTUVAISEHKOLLAISMAISEKKUUDELLISENNESKENTELUTTELEMATTOMAMMUUKSISSANSAKAANKOPAHAN. Then there is a cheese made in OBERAMMERGAU which is described in seventy-one letters, thus: OBERAMMERGAUERPASSIONSFESTSPIELALPENKRAUTERKLOSTERDELIKATFRUHSTUCKSKASE. You might by now, be ready to pronounce this Polish word which means "ceased drizzling," and is spelled ODZDZDZY.—W. H. S., Chicago, Ill.

Get a Machine and Find Out What Wages You're Worth

How do you other readers determine what your work is worth? Many young people probably have had this experience: When applying for jobs they were asked what their labors are worth, and of course, having no idea, mentioned previous wages, and took jobs for the same wages or less. Too bad they did not know. Any increase in pay was at the discretion of the employer, unless the employee became skilled in some work, and even then he had no idea what his labor was really worth. How would you decide what your labor is worth? By the work you accomplish? How would you compare that work with other kinds of work? Why not find out what you should receive before you apply for work? Probably the most difficult procedure would be to make some sort of machine to attach to individuals to be tested, the machine to register calories expended by those persons. Such a method probably would not find much favor. Another method would be to determine how capable a person is. We all understand how our energy depends on the oxygen we breathe. The size and expansion of the lungs show very closely the energy of one person as compared with the energies of others. One third of the blood carrying oxygen goes to the brain, the other two thirds to the rest of the body. Mental tests concerning every division of thought can easily be made. Tests can be in subjects taught in public schools. The nation's income should be equal to the nation's production, and the labor of the average citizen should be worth the average income of citizens of the nation. What do you think?—R. H., Colorado Springs, Colo.

This Bee Stuff Seems All a Matter of Sex

NO DOUBT R. P. D., San Antonio, Texas, is a past master on the radio antennae of cockroaches, bugs, and snails, but when he undertakes to tell us that a worker bee is a "he," and of the exactness with which "he" brings "his" load of pollen to the hive, he is only exposing his ignorance of bees. No worker bee was ever a "he." "He" bees (drones) never bring pollen, nor anything else, to the hive. If R. P. D. wants pollen, or honey, or even wants to get stung, he'll have to look to the

"she" bees, the workers, because "he" bees don't do such things, in our part of the country, and I doubt if they do in Texas.—C. H. P., Canaan, Conn.

Blue Moon Seen by an Amateur Microscopist

L. M. G., of Lewistown, Pa., asks if a rainbow has even been seen that was caused by the moon. Yes, such rainbows have been seen often on the west coast of Florida. Another phenomenon seen here is the "blue moon." Probably due to a light cloud formation at great height, and which cannot be detected, the moon appears to be a delicate shade of blue and the light shed by the moon on such nights is also blue. . . . I follow the hobby of microscopy and enjoy your articles on the microscope very much. Have made a scrap book of all the articles and am keeping them for future reference. I enjoy photo-microscopy and have obtained fairly good results using a small amateur microscope and a vest-pocket camera. I have found the eyepiece lenses of a cheap triplet-lens microscope to be useful when mounted under the stage and used as a substage condenser. The improvised condenser is mounted between the arms of the mirror clip and can be focused by sliding between the arms. A small piece of ground glass set under the stage will cut down the eye strain and still give enough illumination for studying large subjects.—S. P. C., St. Petersburg, Fla.

Shucks! Mirages Common Enough—If You Look

FEW people have had the opportunity of seeing as spectacular mirages as those of which you published photographs last month. But we do observe mirages in one form or another more often than we realize. Driving along an asphalt road in my car, on a hot summer day when the air is calm, I have often seen what at first appeared to be puddles of water lying in the road. At close range the puddles vanished, and no doubt they were a small-scale counterpart of the imaginary pools and lakes seen by desert travelers. The principle of the mirage has a practical use, too, for surveyors making a triangulation across a large water area such as the Gulf of St. Lawrence. Low hills on the far side, that would otherwise be invisible because of the earth's curvature, are actually lifted into view by the refraction of the earth's atmosphere, enabling a surveyor to see over the hump and make his measurements.—G. H. D., Lawrence, Kansas.

Have You Seen One of These Displays in Your Town?

YOU'LL have to pardon my exuberance, but I simply have to tell you I just got a real kick out of something I saw right here in the Old Home Town. Walking by one of our thoroughly up-to-snuff stores, what did I see in the display window but a nifty collection of microscopes shining gaily against a background of my favorite magazine, good old POPULAR SCIENCE MONTHLY. I shouted "Hip, hip," for that store keeper and for the splendid articles on the microscope that you have been printing. More power to all of you.—J. B. S., Grand Rapids, Mich.

Dispelling the Darkness of Our Alleged Mistake

IN A recent issue of POPULAR SCIENCE MONTHLY, there is an article entitled, "Constructing a Light, Adjustable Drafting Table." When I learned drafting, I was told that the source of light should be always on the right side of the draftsman. This is something regarding which most people agree and which, for obvious reasons, is preferable. You will notice that the table of your article is constructed otherwise. To my mind, a serious offense. Perhaps you will say that other uses for the table are possible. Fair enough, but if the table is intended for drafting it should be constructed for that purpose.—H. C. Jr., Westfield, N. J.

National Homeworkshop Guild Gets a Big Hand

PLANS for a National Homeworkshop Guild is a splendid idea. Congratulations to POPULAR SCIENCE MONTHLY upon its selection as the official organ of such a worthy movement.—R. G. B., Monterey Park, Calif.

THE National Homeworkshop Guild is an undertaking thoroughly worthwhile and one of which I heartily approve. I shall certainly do all I can to help.—J. G. P., Washington, D. C.

BEING an enthusiastic home workshop individual, I am all for the National Guild and I shall get busy and do what I can.—T. B. O., Cleveland, Ohio.

I WILL do everything possible to get a Homeworkshop Guild club started in this locality—D. A. P., Chicago Heights, Ill.

I AM very much interested in the proposed Homeworkshop Guild as I have had something of the kind in mind for a number of years. I will do what I can to promote an interest in the Guild.—E. D. H., Lawrence, Kan.

WITH POPULAR SCIENCE MONTHLY boosting the Guild movement, I am sure it will be carried out in a proper manner. I am definitely for such an organization and will use whatever ability I possess to help start a local organization.—W. L. F., San Francisco, Calif.

I THINK the idea is wonderful and I shall make a survey of the sincere handicrafters of this town and get them in touch with each other.—C. B. W., Summit, N. J.

No Oxidation in Tires Filled With Nitrogen

Answering J. K. F. of Cincinnati: Nitrogen is preferred to air for the inflation of tires because it does not cause oxidation of the rubber under the temperatures generated by high-speed travel. This oxidation of the rubber weakens the tire and causes increased wear. I find your magazine a veritable gold mine of practical and informative facts.—R. F. W., New York, N. Y.

Flash Light on Gun, Too Much for This Reader

IF THE item in a recent issue "Flash Light On Big Gun" was only posed in an effort to stimulate sales for oversize or overstocked flash lights it is poorly put. Parties that know as little about hunting as the item indicates should not be allowed to handle guns or molest game animals. Killing swordfish as the photo indicates is not possible. The reel has not yet been invented that will let out line against a thrust as the picture indicates.—C. B. S., San Jose, Costa Rica.

You Can't Tell Where Queer Fish Will Bob Up

I HAD often heard the story that many fish return to the place of their birth to do their own spawning but never believed it. The other day, I ran across a newspaper item telling how a whole school of river salmon had recently returned to the fish hatchery on the edge of the river to deposite their eggs. What brought these fish back to the place of their birth? Was it taste, smell, or just natural ability to remember geographical characteristics? Why not run an article on the queer habits of fish and include in it some facts that tend to show that fish like other animals have the ability to think, taste, and remember?—F. P., Newark, N. J.

Here's a New Slant On That Hind-Horse Problem

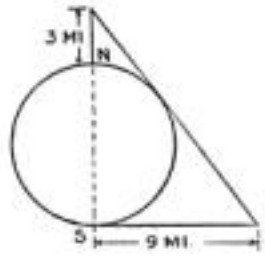
IN A recent issue of POPULAR SCIENCE MONTHLY, O. L. G., of Rockton, Ill., seems to be much worried about whether the fore or aft horse pulls the most. While he is right in saying that most farmers will tell you that the horse which is behind is pulling the harder, that is an erroneous opinion. What a farmer really means is: the horse that is behind must work harder to catch up with the other horse. Common sense shows that the horse behind does no more work for if at the start of the pull one horse is six inches behind the other and at the finish is still six inches behind, he very obviously has walked the same distance and has exerted the same force. As to the comparison with the scale balance, just put a strong horse and a weak horse together and see what happens. The strong horse will pull the weak horse back just the same as more weight in one pan raises the other pan.—L. C. W., Plankinton, S. D.

He's Appreciative But Still Hungry for More

I SUGGEST we have more experimental chemistry in your publication. I am quite sure all we amateur chemists fully appreciate the chemistry and microscopy articles which you do publish, but we assure you the more of them the better.—G. A., Murray, Ia.

Ancient Chinese Problem Will Exercise Your Mathematics

HERE is a little problem which may interest some of your readers as it is so old that it may be new. A chinese mathematician, Chin Chiu Shao, who wrote the "Nine Sections" in the year 1247, proposed the following problem: There is a circular City of unknown diameter having four gates. Three miles north of the north gate is a tree which is just visible from a point nine miles east of the south gate. Find diameter of City. Just a little geometry and algebra is all that is required in order to get a correct solution.—C. D., Courtenay, B. C., Can.



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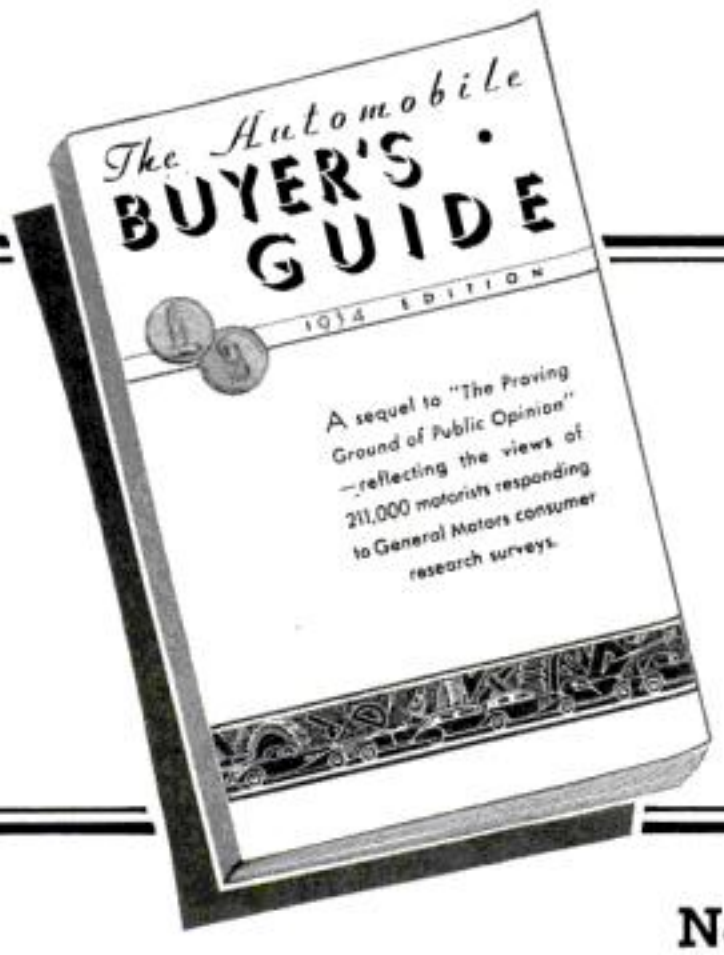

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POPULAR SCIENCE
MONTHLY
February 1934 Vol. 124, No. 2
RAYMOND J. BROWN, *Editor*

Regularly recurring sunspots, huge eruptions on the sun's face, bombard the earth with streams of electrons. Study of these volcanoes of fiery gas indicate that they have profound bearing on weather, on radio reception and on the health of the people

New Discoveries SHOW Electricity GOVERNS OUR LIVES

By Edwin Teale

EXPLORERS, working in one of the strangest realms of science, are unearthing curious, dramatic facts.

The way autos run, the way seeds sprout, the way eggs hatch, the way radios function, and even the way we feel when we get up in the morning, the latest tests have shown, are affected by flowing, invisible charges of electric power. Recently, experiments in the laboratories of many lands have added to our knowledge of the magical work of electricity in the air.

In Italy, one scientist has sent electric waves racing through the atmosphere to alter the heredity of plants. In Holland, another has used them to kill bacteria and preserve foods. In Germany, a third has obtained astonishing results by administering electrified air to hospital patients. In the United States, two of the country's foremost surgeons have just announced the discovery that minute electrical charges are vital to our brains and bodies.

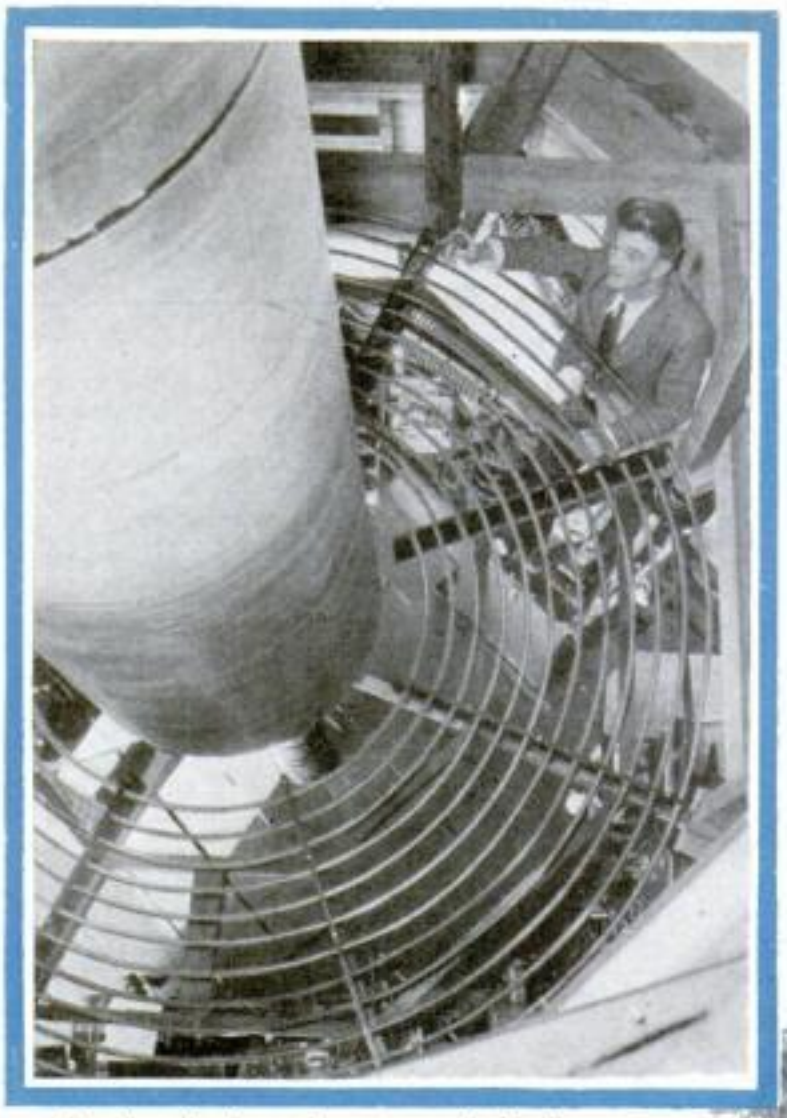
From their study of electrical winds and magnetic storms, solar smoke and electrified dust, the workers hope to find the answers to age-old puzzles of Nature. Many scientists believe that the keys to the most baffling enigmas of earth, the mysteries of life, heredity, and death, lie locked in infinitesimal particles charged with electricity. No other field of modern research is so packed with mystery and promise.

One first-class mystery occurred not long ago near Denver, Colo. More than a hundred automobiles on the road between Denver and Boulder were caught in a howling gale. Flying sand grains filled the air. Suddenly the motors in the cars began to stop. All along the road, stranded motorists churned their selfstarters unable to understand why the engines wouldn't function. Then the wind abated, the engines started, and the cars rolled on. Some mysterious force, generated by the fury of the storm, had thrown the ignition systems temporarily out of order.

This weird performance recalls the rumors during the World War of a mystery ray that was supposed to stop motors and bring down planes. A few weeks ago, an Austrian announced he had actually perfected such an

BALL LIGHTNING CAUGHT BY CAMERA

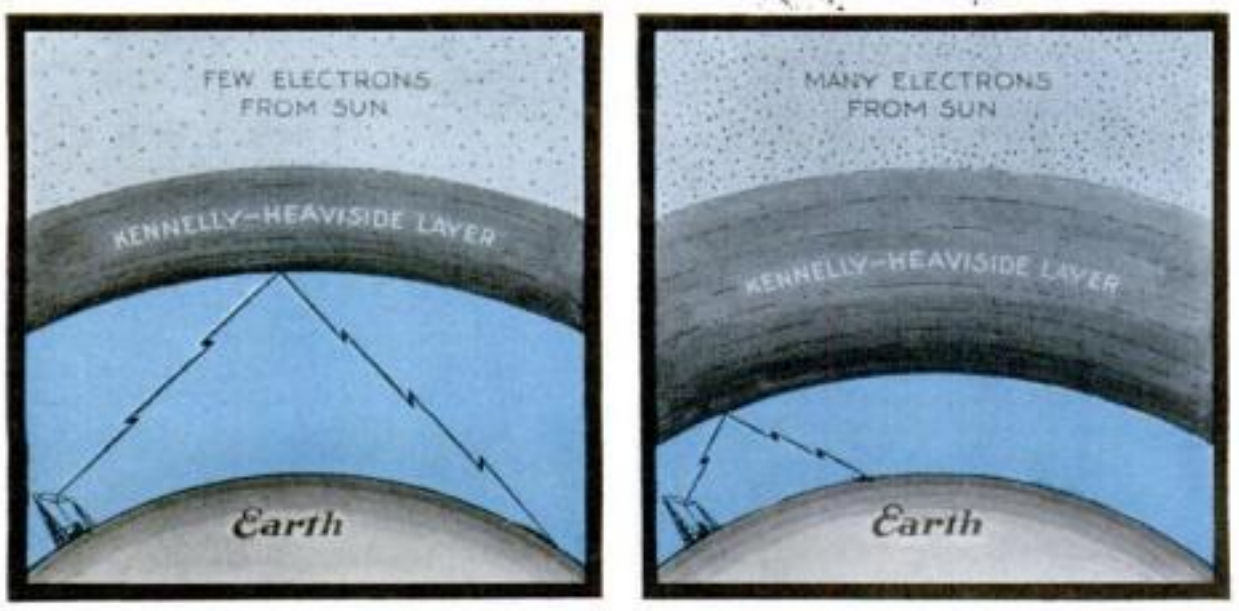
This remarkable photograph, one of the first ever taken of ball lightning, was made recently by Prof. J. C. Jensen, of Nebraska Wesleyan University, near Lincoln, Nebr.



Interior of electrodome tower built in California by William Haight who is seen in the photo. It is intended to dispel fog

ELECTRIC CURRENT TO DISPEL FROST

Below, an exterior view of the electrodome tower, that was built to dispel fog and frost. At left is an interior view of the tower. It discharges a negative current of eletricity into the air, the ions of which then may clarify the atmosphere

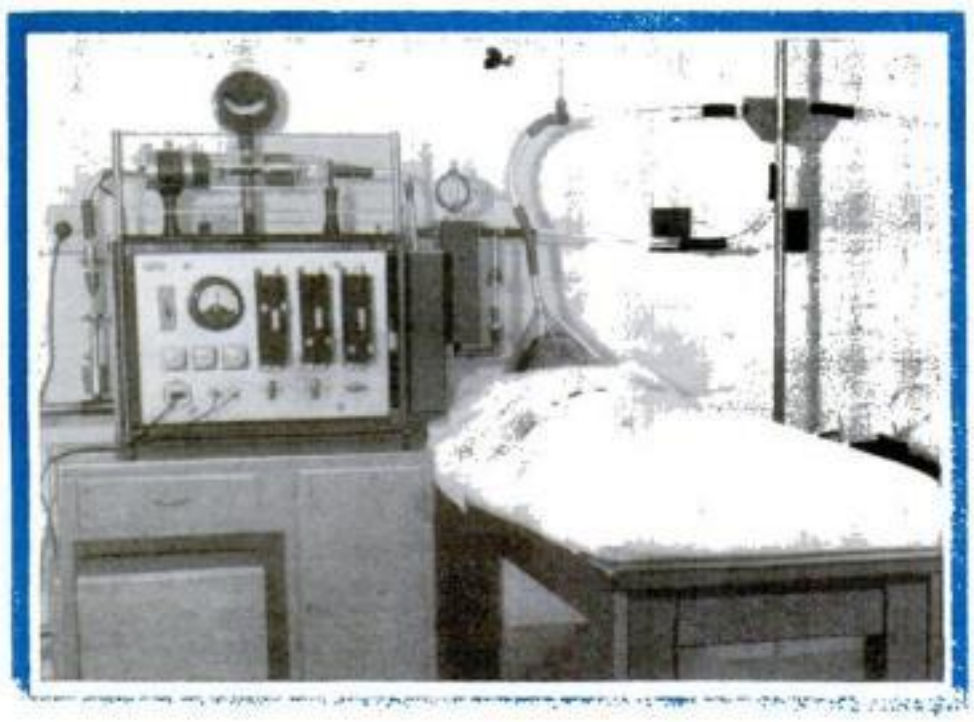


ELECTRONS FROM SUN INTERFERE WITH RADIO WAVES

The illustration at upper left shows the condition of Kennelly-Heaviside layer when there are few sunspots and good radio transmission. At right, maximum spots and bad reception

IONS USED IN FIGHT ON DISEASE

This Dessauer ion apparatus has been installed in the Beth Israel hospital, New York City. The highly electrified air it supplies is used in treating rheumatism and high blood pressure



apparatus. According to his claims, the invention projects ultra-short electric waves into the sky to interfere with ignition systems of planes.

A hint of what happened to the cars on the Colorado road is given by a discovery that has been made by scientists in several parts of the world. Sand storms, it has been found, always generate electricity. Sometimes, the electric particles, or ions, they produce are positive, sometimes negative. It seems to depend upon the chemical composition of the sand and dust. In South Africa, where the rock is largely quartz, the electric particles are always positive; in England, where limestone is the prevailing rock, dust clouds carried by the wind from well-traveled roads are always ionized with charges of the opposite, or negative, electricity.

Applying this knowledge, Richard E. Vollrath, a young California inventor, has developed an ingenious sand-storm generator. It sends blasts of dust-laden air through copper tubes, generating electricity which is stored in a huge metal sphere. During one test, the electrical charge thus built up is said to have reached 260,000 volts.

The fact that the power of your auto engine varies according to the amount of electricity in the atmosphere was suggested by experiments made at the U. S. Bureau of Standards, in Washington, D. C., last spring. The air at the carburetor intake was charged with different concentrations of ions and the power of the motor was found to fluctuate as the number of electrified particles changed.

At the present time, radio reception is the best it has been since 1923. Long distance signals are coming in more clearly and regularly than at any other time in the last decade. Changes in atmospheric electricity, caused by a minimum of sunspots, is accepted as the explanation. In regular cycles of approximately eleven years, these volcanoes of fiery gas on the surface of the sun increase and decrease in number. They are now at their lowest point. During the next five years, an increasing number will troop across the face of the sun until the high point is reached about 1939. Then they will become fewer and fewer until, in 1945, they will have disappeared entirely and another sunspot cycle will have come to an end.

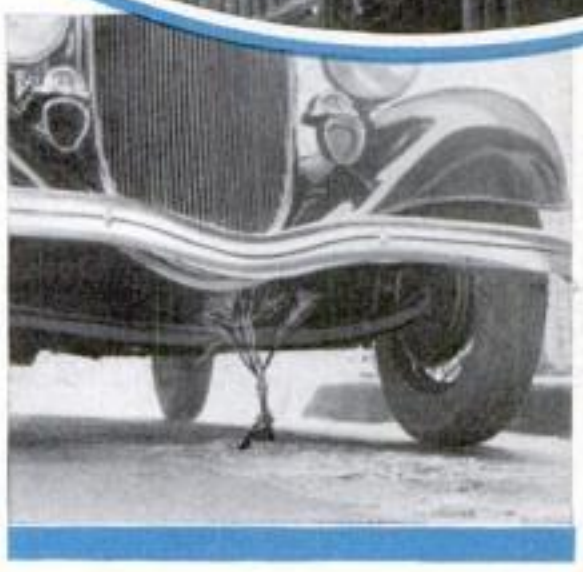
To learn more about the relation of sunspots and radio, a famous astronomer and a noted engineer have been making tests for the last seven years. They are Dr. Harlan T. Stetson, Director of the Perkins Observatory at Ohio Wesleyan University, and Dr. Greenleaf W. Pickard, radio inventor and one of the first men in America to transmit speech by electrical waves. While Dr. Stetson observed and photographed the sunspots from day to day, his co-worker noted accompanying variations in the strength of radio waves received from a distant broadcasting station.

When the spots were increasing, during 1926, 1927, and 1928, the radio signals grew fainter and fainter. But from 1929 on, as the spots decreased, they gained in strength. The reason, the scientists conclude, is that the huge envelope of ionized particles which surrounds the earth and is known, after its discoverers, as the

ARCTIC'S GREAT MYSTERY PHOTOGRAPHED

Using motion picture cameras, scientists of the Heinrich Hertz Institute, Germany, made unusual pictures, in the far north, of the phenomenon, aurora borealis, shown in this photograph

In oval, ion counter, designed by Dr. L. R. Koller, left, has been installed in an air-conditioned house in Schenectady, N. Y. It will be used to study the effect of electric particles in the air, upon the health of those in the house



Motorists in the South were often severely shocked when their hands touched that of a bridge toll collecter. This was found due to the accumulation of static electricity in the cars. The wire tree, seen at left, was installed in the bridge. Meeting the metal frame of the car it removes charge and protects drivers

Kennelly-Heaviside layer, is affected by changes in the sun.

Like an immense cathode ray tube, the sun bombards the earth with streams of electrons. As these strike our outer atmosphere, they break up its tiny particles into positive and negative ions. This blanket of electrified particles, some seventy miles above the earth's surface, serves as a gigantic mirror, reflecting or bending sky-bound radio waves back to earth. It is only because the waves are thus reflected or refracted by this shell of ions that they are able to travel long distances and circle the earth.

The degree to which the layer is ionized depends upon the activity of the sun. When the sun is most active, that is, when it is dotted with the most sunspots, the greatest number of electrons shoot from it and increased ionization of the Kennelly-Heaviside layer pushes it down nearer the earth's surface. This in turn bends the radio waves back more abruptly and cuts down the distance they travel.

On the other hand, any decrease in the activity of the sun reduces the intensity of the ionization of the layer, allows it to thin out and rise, thus bending back the waves less abruptly and sending them for longer distances along the surface of the earth. In this manner, the expanding and contracting of a shell-like reflector surrounding the earth, controls the effective distance radio waves will travel.

The moon, as well as the sun, Dr. Stetson reports, has a definite influence over radio reception. Analyzing signals broadcast between Chicago and Boston, he found their strength increased as the moon dipped below the horizon and decreased as it rose overhead. This is due, he believes, to radium rays from the moon, which tend to push down the layer as the moon passes above, thus reducing the distance radio waves can travel.

On all sides of us—floating in the air, streaming from the sun, coursing through our bodies, hidden in the things we eat—are minute charges of electricity. Only in recent years have we known much about these invisible ions. It is thought they usually start out as atoms from which an electron is removed. On sunny days, it is known, there are more ions in the air than on cloudy days; on warm days more than on cold days; on clear days more than when smoke pollutes the sky.

From hour to hour, even from minute to minute, the number of ions in the air varies. It shifts according to the ebb and flow of a titanic battle which goes on unceasingly and unseen around us. This is the struggle between the forces that create ions and the forces that destroy them.

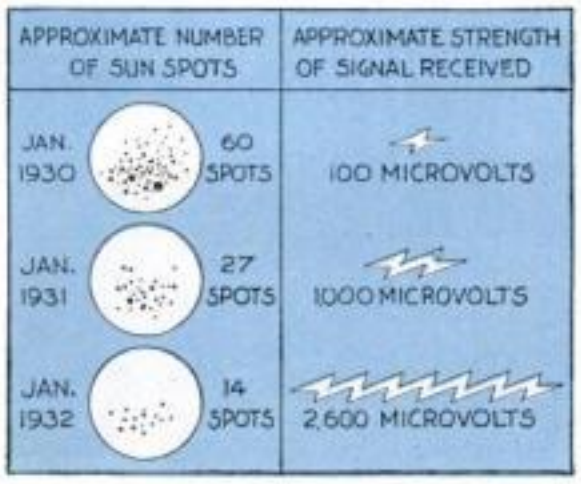


Illustration showing the manner in which the strength of radio signals increased as the number of sunspots decreased from 1930 to 1932. Illustration on opposite page explains this

On the side of the ions, the three most powerful allies are: the constant bombardment of the atmosphere by cosmic rays from outer space, the radiation from the sun, and the work of radioactive materials, such as radium, on and below the surface of the earth.

Streaming from the sun are large quantities of exceedingly fine, electrically charged particles. Some scientists call this moving mass solar smoke. As this stream of charged particles approaches us, it comes under the influence of the earth's magnetic field, and divides into two streams that diverge toward the two magnetic poles. Reaching the outer atmosphere of the polar regions, the particles often collide with the molecules of the air and become discharged, thus producing the beautiful display known as the aurora. The discharged particles, remaining suspended in the upper air, serve as the nuclei for the formation of the high, feathery cirrus clouds.

Waterfalls are also ion factories. Niagara, for instance, charges its water with positive, and the air around the chasm with negative electricity. Splashing water and spray create ions, too. A curious fact in this connection is that salt water spray charges the air around it with positive ions while fresh water charges it with negative ions. Large raindrops become positively charged when they are flattened and broken up by the resistance of the air. In the very highest clouds, other ions are believed to be formed by photo-electric activity among the ice needles. Near the ground, the number of ions is augmented by winds that blow over metals and other surfaces.

Recently, such electricity-bearing winds have been *(Continued on page 100)*

• *Automobile Traditions Challenged by*

First Streamlined Stock Cars

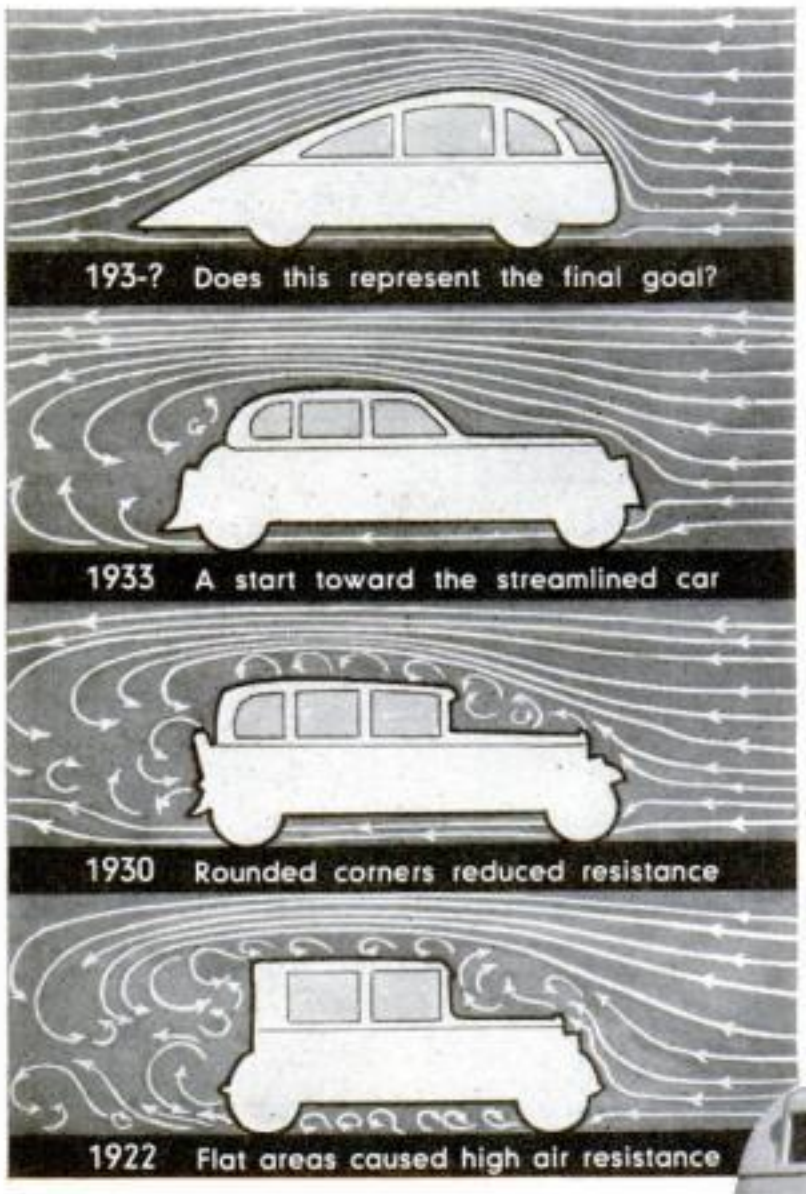


Chart of the cars of the last eleven years, showing how the gradual evolution of the streamlined shape has reduced wind resistance so they slip more easily through the opposing air currents

AS THIS issue of POPULAR SCIENCE MONTHLY is published, in automobile shows and dealers' showrooms all over the country are being exhibited the world's first scientificially streamlined stock cars. Introduced by leading American manufacturers, they mark a new stride toward a goal to which automotive engineers have been working for years—the development of a car in which fuel economy, riding comfort, and speed are brought about by reducing to a minimum the losing battle with air resistance that has been waged by every automobile that ever was placed on the roads.

There have been streamlined cars before—experimental cars. Designers and drivers of racing cars and the freak vehicles built for a single try at a world's record also have utilized streamlining principles in body construction. Speedway daredevils, for example, for years have been tying and taping streamlined wooden forms to the rear of their axles to cut down wind resistance a trifle. Aviation and automobile engineers, research men in aerodynamic laboratories, and designers of railway rolling stock long ago worked out the "teardrop" form that means minimum air resistance in a moving vehicle. But an attempt to use fully the known principles of streamlining in a stock passenger automobile never had been made until it was decided that this year the motoring public was ready to accept what hitherto had been called "the car of the future."

Standard cars in the past have had flattened mudguards, rounded projecting corners, reshaped radiators and slanted windshields, as a gesture toward streamlining. But solving the real problems of streamlining meant entirely redesigning the body to secure a new shape around which the air currents would flow smoothly, meeting at the back without any swirls or disturbances. The task was further complicated by the car's wheels, axles, door handles and other features, each presenting its own streamlining difficulties. Obviously, then, the problem confronting the automotive engineers who designed the new machines, of which the public is, at this moment getting its first view, was highly involved and could not be solved in a moment.

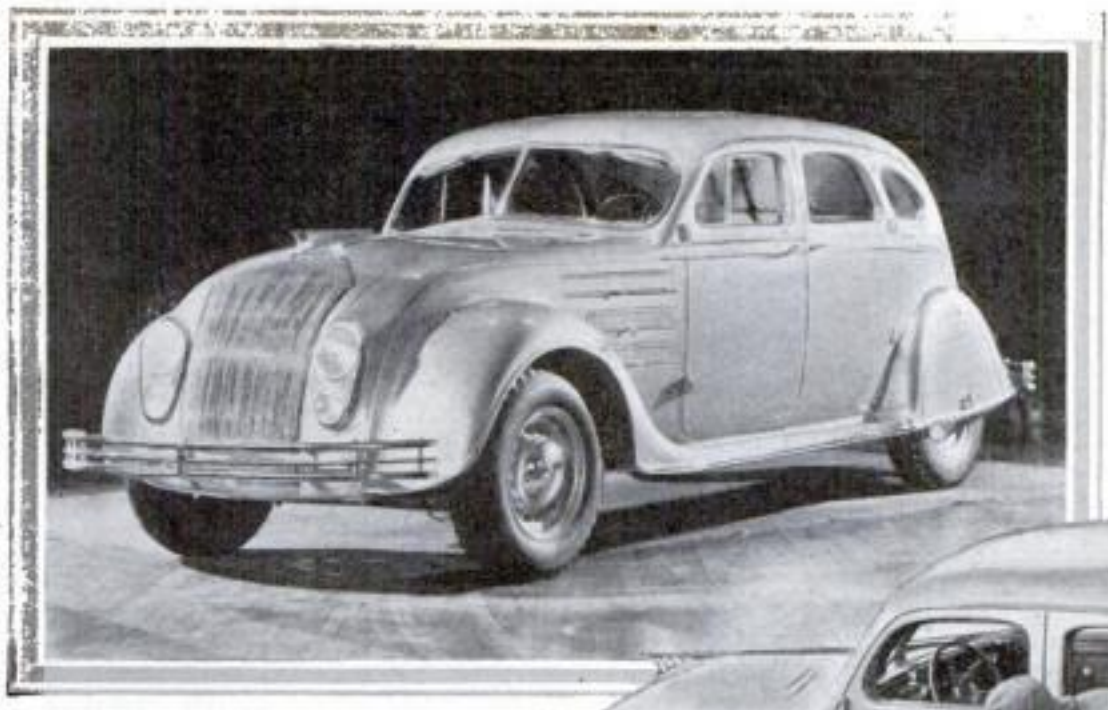
Late in the summer of 1927, the engineers tackling this job, decided to start from scratch and learn for themselves all they could about air pressure and a moving body. To do this they enlisted the aid of Orville Wright who helped them build an inexpensive wind tunnel such as he and his brother, Wilbur, had used when they invented the airplane. The tunnel was set up in a locked room in Dayton, O., a secret laboratory hardly more than twenty feet square.

Here the workers carved small wooden blocks into every imaginable shape. They mounted them on ball bearing rollers and placed them on metal tracks in the blast of the wind tunnel. A cord ran from each block over a pulley to a

Streamlined and equipped with radio this modern taxi, forerunner of the future styles, is the first one in active service

With present body designs, cars run better rear end first, as was shown when this car was driven thus in New York City

Startling Changes in Body Design Are Expected to Boost Road Speed and Cut the Cost of Operation



Two of the 1934-model streamlined stock cars, above and at right, now being shown in salesrooms throughout the country

By ROBERT E. MARTIN

weight resting on a simple post-office type scales placed on the floor. As the air resistance drove the block back, the cord lifted more and more of the weight from the scales. Thus the experimenters could easily determine the resistance of any given block in ounces simply by subtracting the reading when the cord was pulling from the reading when it was relaxed and not under strain.

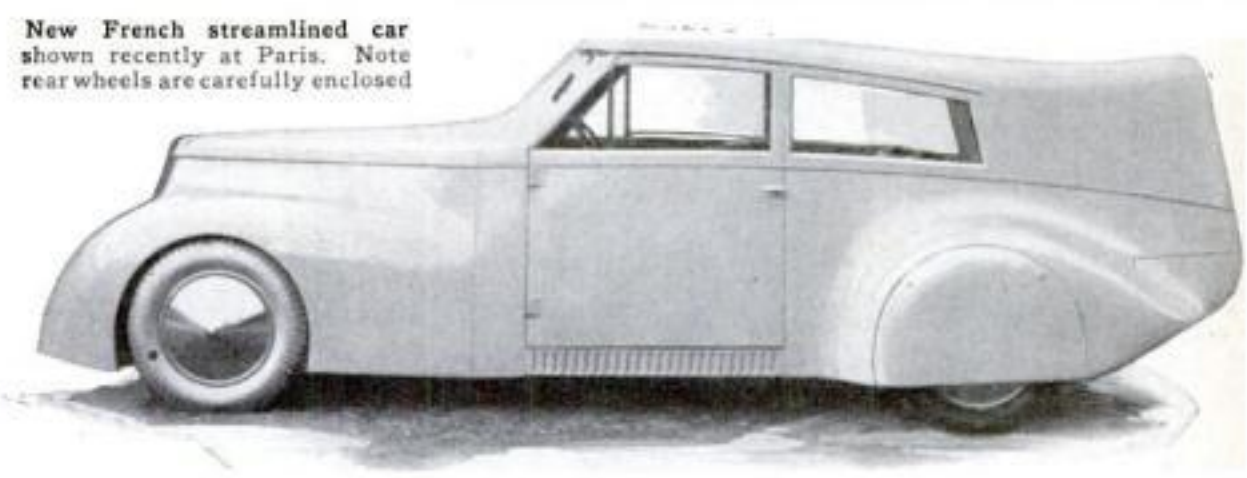
Immediately, surprising discoveries began to pop up. So far as efficiency in the matter of wind resistance is concerned, the engineers found, all the cars in the world are running backward! If they were turned end for end on their chassis, with the blunt rear facing forward and the narrow hood behind, the air would offer far less resistance to their passage. Not long ago, Harry Hartz, the noted racing driver, amazed New Yorkers by driving down Broadway in a sedan whose body was reversed on its chassis.

In many of the tests, the same blocks were altered slightly and the differences in resistance noted. They showed me blocks in which notches were cut, bulges added, tops altered, sides changed. And each variation left its record on the data sheets of the investigators.

Then streamers of silk were added to the tunnel equipment. As long as the air flowed smoothly, they stretched out straight as pencils. But when they struck disturbed currents, they vibrated violently, permitting the engineers to study the exact location and extent of the various swirls. Smoke streamers gave additional information about what happened to the currents and finally, the air was made to write its own record through an arrangement of metal plates and lampblack.

In explaining the process, they showed me block models which were bisected fore and aft vertically and had the two halves clamped together with an upright metal plate between them. This plate was heavily coated with a mixture of lampblack and linseed oil. At the end of the test, the wind had carved its record on the plate. Where its velocity was greatest, the metal was bare, all the coating having been carried away. A careful comparison of the amount of lampblack remaining on different parts of the plate gave a complete picture of how the currents had acted in passing over the block. Scores of these wind-written records were assembled. They gave invaluable insight into the problems of rear-end eddies and front-end disturbances. Thus they slowly worked out the designs now on the market and at the same time learned some curious things about the cars and air pressure.

Photo shows wide front seat capable of seating three persons with ease



New French streamlined car shown recently at Paris. Note rear wheels are carefully enclosed

For instance, when Sir Malcolm Campbell streaked across the wet sand at Daytona Beach, Fla., last February, his Blue Bird was traveling 272 miles an hour. The spectators saw the moisture sucked up from the sand twenty feet ahead of the flying car. The nose of the Blue Bird was driving a cone of air before it as it bored its way through the atmosphere.

While a twenty-eight-inch cube of air weighs only a pound, as compared to 100 pounds for a similar cube of water and 784 pounds for one of steel, its resistance climbs rapidly with speed. At Campbell's pace, the air *(Continued on page 97)*

Combination health lamp that gives ultra-violet and heat rays. Below, close-up of the electrical unit

ULTRA-VIOLET AND HEAT RAYS FROM NEW LAMP

ULTRA-VIOLET and heat rays are both provided by a combination health lamp just introduced. Its heating element serves as electrical resistance for an arc that is formed between two carbon electrodes, which are held in spring clips and adjusted by hand. When it is desired to use the heating coil alone, one of the electrodes is removed and the other is pushed all the way through the holder, completing the electrical circuit and preventing an arc.

BUILDING CHURCH IS A JIG-SAW PUZZLE

SOLVING one of the world's biggest jig-saw puzzles was the recent task workmen were called upon to perform when St. Andrew's Church, in London, England, was moved to the suburbs. The removal was made necessary by a dwindling congregation and the encroachment of business places. As each stone was taken down at the old site, it was carefully numbered and then transported to the new location. There laborers fitted the stones together again. The trying task, which still awaits completion, will have consumed about twelve months. In the photograph above, the transplanted church is seen beginning to take shape at its new site.

USE SPRAY ON THIRD RAIL TO KEEP OFF ICE

SPRAYING anti-freeze solution on the third rail to prevent the formation of ice is the novel expedient with which British railways are experimenting to end this nuisance. At the first threat of frost, a special car containing the spraying apparatus is sent over the line and applies the liquid from a nozzle close to the rail, as shown at right. A revolving ice cutter and a brush to sweep away the chips precede the jet of anti-freeze compound. In this way it is expected time and labor will be saved.

NEW PLANE HAS VERTICAL PROPELLERS

Vertical propellers on this plane are designed to help it in taking off or landing

VERTICAL propellers, driven by compressed air and designed to aid in landing or taking off, are a part of a plane now under construction near San Francisco, Calif. The machine, of which a model is shown above, will seat three passengers and have a wing spread of thirty feet.

AMERICAN BUSES FOR SYRIAN DESERT

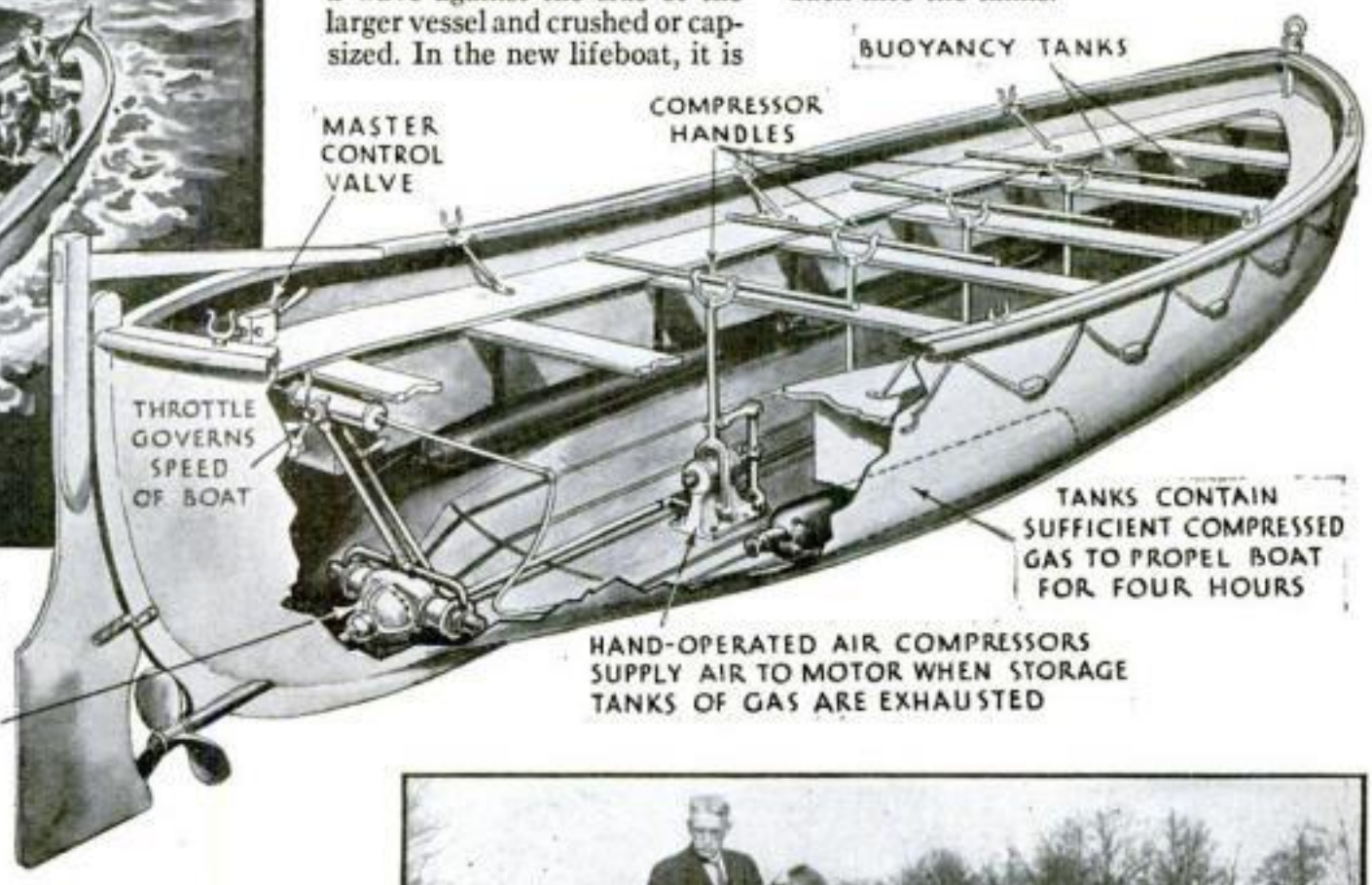
MONSTER Diesel-powered buses of American manufacture will soon inaugurate a 700-mile transport line for passengers and freight across the trackless wastes of the Syrian desert, linking the storied cities of Damascus and Baghdad. A veritable liner of the desert, the passenger bus measures sixty-six feet long and carries thirty-six passengers.

American-built passenger bus that will be used in the Syrian desert. It can make forty miles an hour

CARBON-DIOXIDE GAS DRIVES BOAT

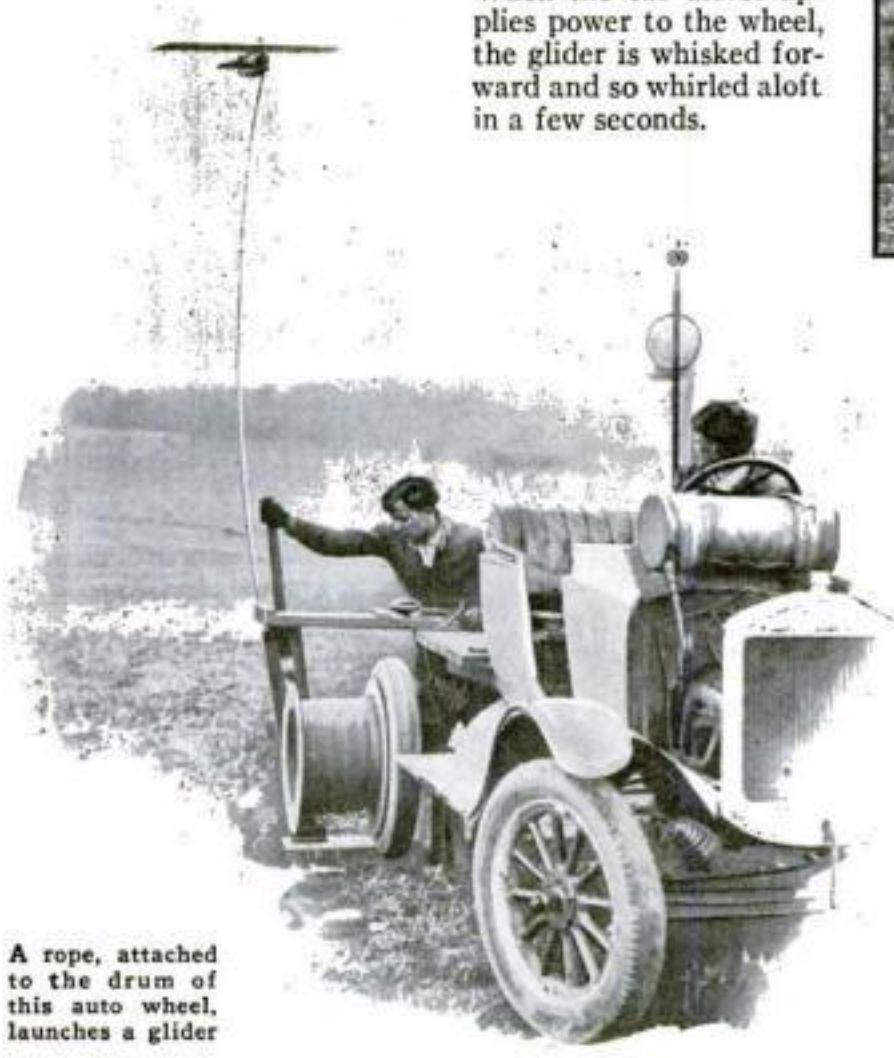
PROPELLED by a motor that runs on compressed gas carried in cylinders, a lifeboat of new design safeguards its passengers' lives at the moment when persons in an ordinary lifeboat are in greatest peril. This is the critical instant after launching, when the lifeboat is in immediate danger of being thrown by a wave against the side of the larger vessel and crushed or capsized. In the new lifeboat, it is necessary only to open a valve, and compressed carbon-dioxide gas from four cylinders hisses into an air motor, whirling a screw propeller and driving the craft to a safe distance in a few seconds' time. If passengers and crew wish to keep the boat running beyond the four-hour capacity of the gas tanks, they may work hand pumps that compress air to operate the motor. Surplus of air from the pumps is automatically fed back into the tanks.

Illustration showing the new lifeboat in action. It is powered with an engine driven by carbon-dioxide gas from its four cylinders

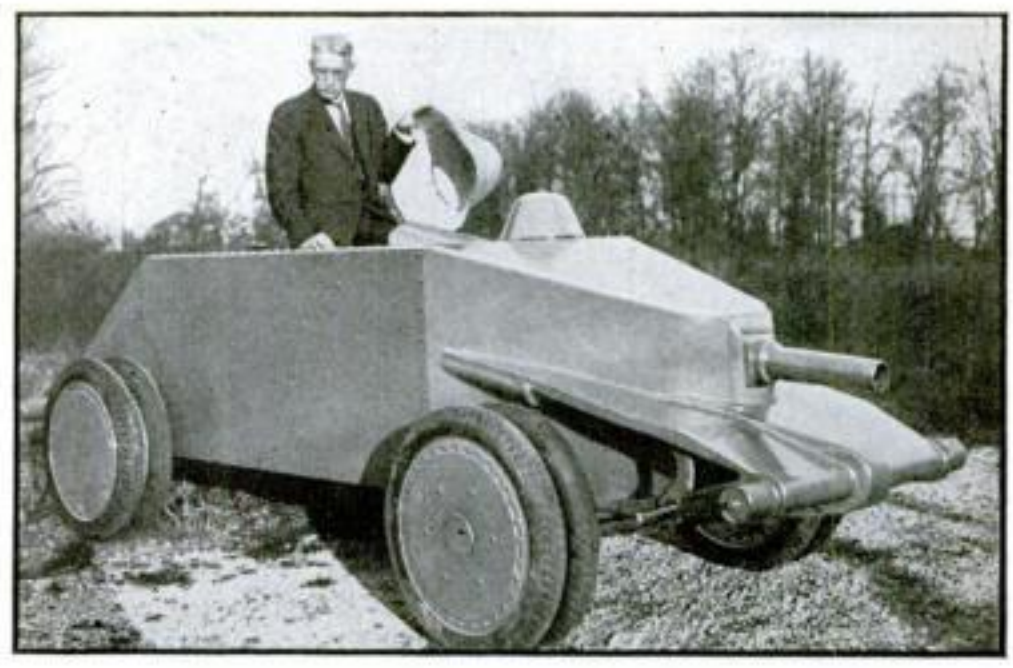


AUTO WHEEL LAUNCHES GLIDER

USING the rear wheel of an automobile to launch a motorless plane is a stunt successfully developed by members of a Newark, N. J., glider club. One end of a 2,000-foot manila rope is attached to the glider and the other to the drum on the car's wheel, which is jacked up for use. When the car driver applies power to the wheel, the glider is whisked forward and so whirled aloft in a few seconds.

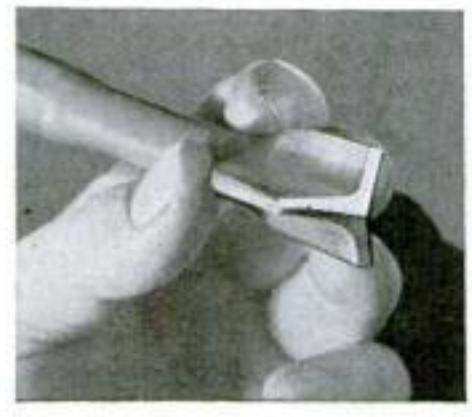


A rope, attached to the drum of this auto wheel, launches a glider



BABY TANK DESIGNED FOR SPEED

MOBILE as an armored car and as formidable as a good-sized field piece, a new type of baby tank, capable of sixty miles an hour, has been developed by J. Walter Christie, of Linden, N. J., who has designed numerous other armored vehicles for the U. S. Army. Trap doors give access to the driver's and gunner's compartments, as demonstrated above by the inventor. A 250-horsepower motor drives the baby tank, which weighs scarcely more than two tons and is expected to be highly effective in action.



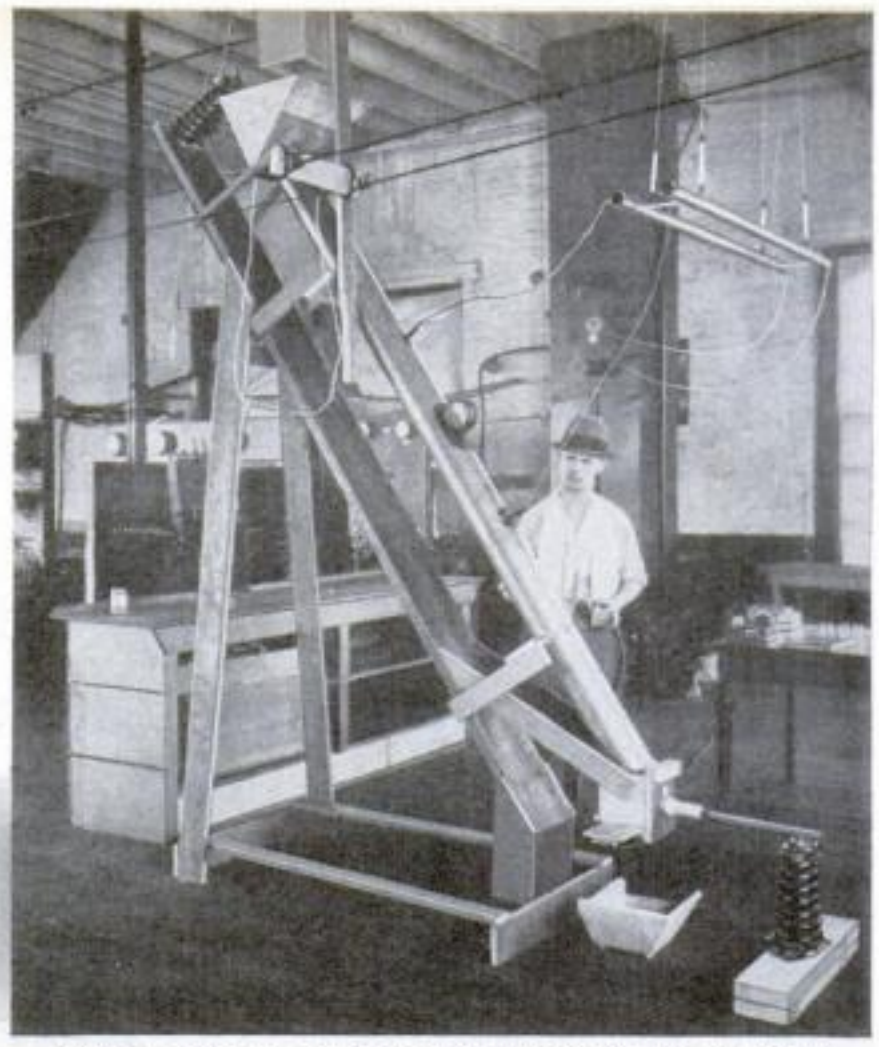
THREE-POINTED MASONRY DRILL

PROVIDED with three points instead of four, a new masonry drill, shown at left, may be resharpened on any grinding wheel. Parallel cutting lips help drill a clean hole. Both hand and power drills of the new type are supplied.

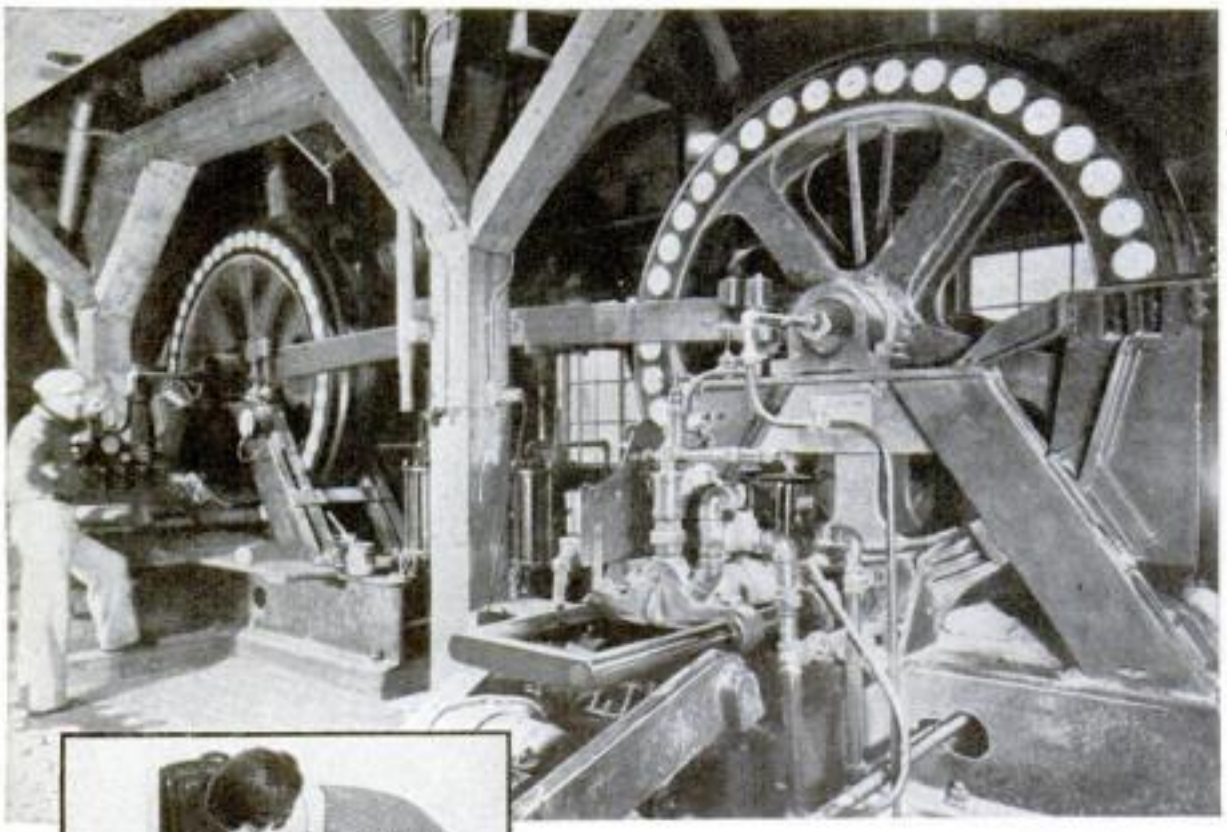
ELECTRICITY TESTED TO KILL PESTS IN STORED GRAIN

KILLING insect pests by high-frequency electricity is a process now being applied experimentally by the Baltimore & Ohio Railroad at Baltimore, Md. Grain awaiting shipment is protected against weevils and other parasites by running it, before storage, between metal electrodes that subject it to a high-frequency electrical field. The waves of electricity are reported to destroy both the weevils and their eggs, and the grain may then be stored without danger of deterioration. The method, and designs of treating apparatus used, were developed by J. H. Davis, chief engineer of electric traction.

Below, typical specimen of wheat damaged by insect pests. At right, wheat samples one of which, left, has been treated with electricity to kill pests. The other shows parasite ravages



With this apparatus, high-frequency electricity is passed through grain before storage to prevent the destructive work of insects



At top, machinery used to compress sawdust into logs. Above, the logs as they appear when ready for use in the home

SAWDUST LOGS PROVIDE NEW FUEL FOR FIREPLACE

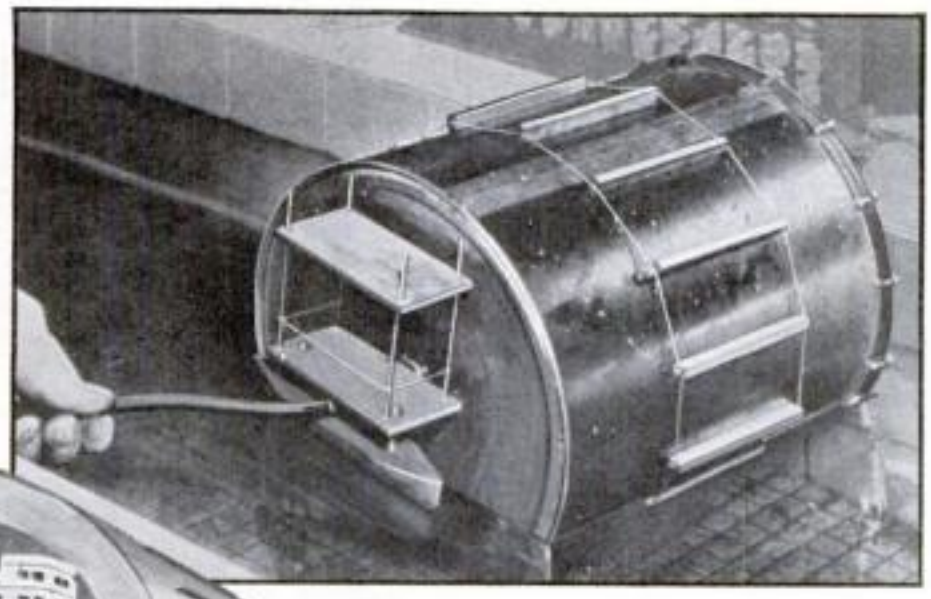
Logs of sawdust, made by a new process from lumber-mill waste, have been introduced by an Idaho firm as fuel for fireplaces, furnaces and stoves. The raw material is compressed in a special machine under a pressure of 20,000 pounds to the square inch, yielding firm cylindrical bars of fuel, four inches in diameter and about a foot long, which resemble natural wood in appearance. Clean to handle, the sawdust logs are declared to burn smokelessly and to provide an abundance of steady heat. An additional advantage, when the logs are used in a fireplace, is that they will not pop or throw sparks, according to the manufacturer. They require little storage space, will keep a long time, and are said to improve materially with age as the log gradually solidifies.

AUTOMATIC CAMERA TO MAP ANTARCTIC WASTE

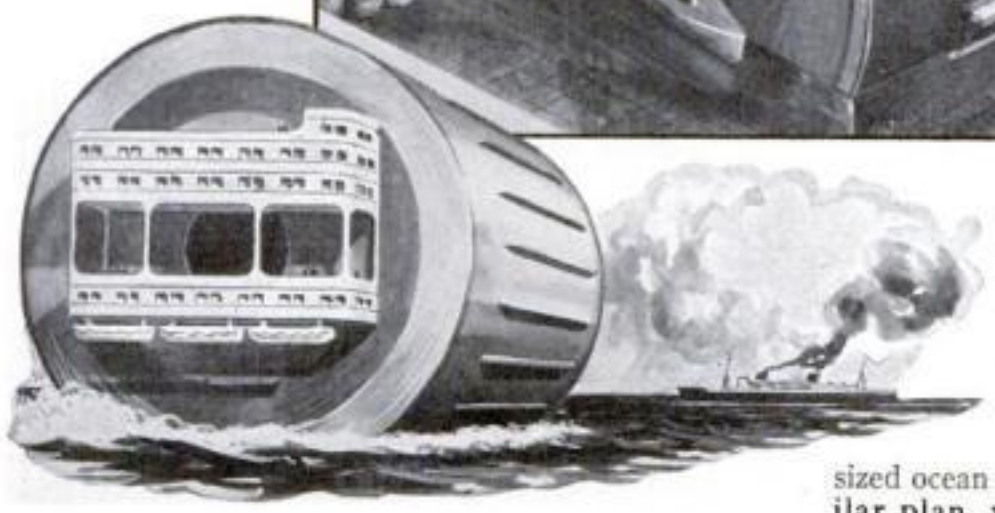
MAKING an unbroken picture of 3,000 miles of new territory crossed by Sir Hubert Wilkins, on his projected airplane dash across the Antarctic ice cap, is the task for which the electric camera, illustrated below, has been designed. Once switched on, it automatically takes one picture each six seconds. The resulting views, when assembled, are expected to yield one of the most nearly perfect map records ever made at either pole. This is the first time thirty-five-millimeter movie film has been used for air mapping.

With this automatic electric camera, which takes a picture every six seconds, an air map of the Antarctic continent will be made

DESIGNS BARREL SHIP FOR USE AT SEA

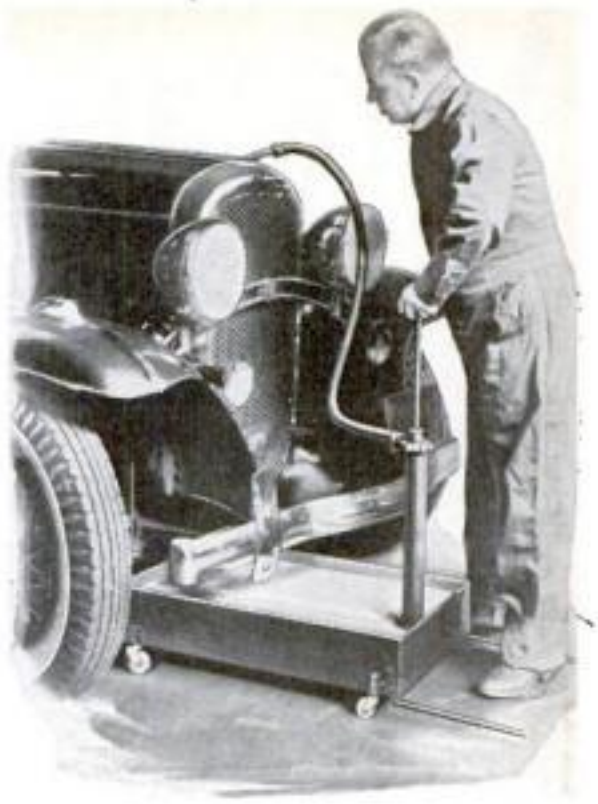


At right, model of a barrel vessel that has been tested in a small tank by its inventor. It is said to have performed in a satisfactory way



A full-sized, ocean-going barrel ship would look like the illustration at left. It would roll over waves

To DEMONSTRATE the feasibility of his design for a high-speed ship that rolls over the water like a barrel, a marine engineer of Port Blakely, Wash., has constructed an electric-powered model that is reported to perform all the maneuvers of a conventional vessel. He proposes building full-sized ocean vessels on a similar plan, with stationary decks for passengers and cargo inside the revolving, electrically driven shell. The project recalls that of another barrel ship inventor of an earlier day, who actually completed a 110-foot model of his steam-powered craft and piloted it 200 miles across Lake Ontario (P.S.M., Dec., '33, p. 26).

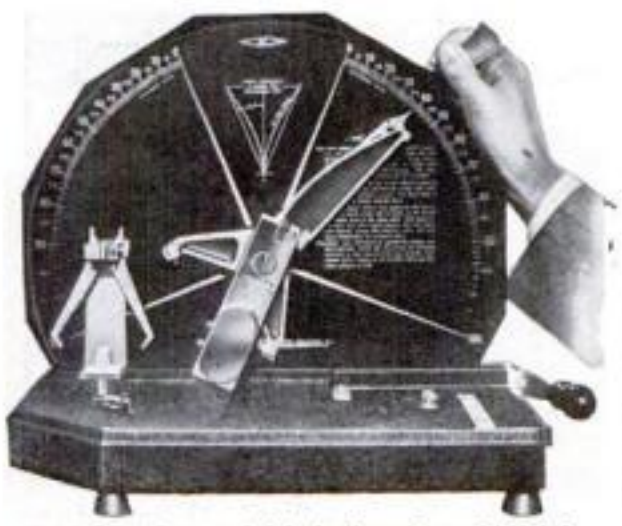


DRAINING WAGON SAVES ANTI-FREEZE MIXTURE

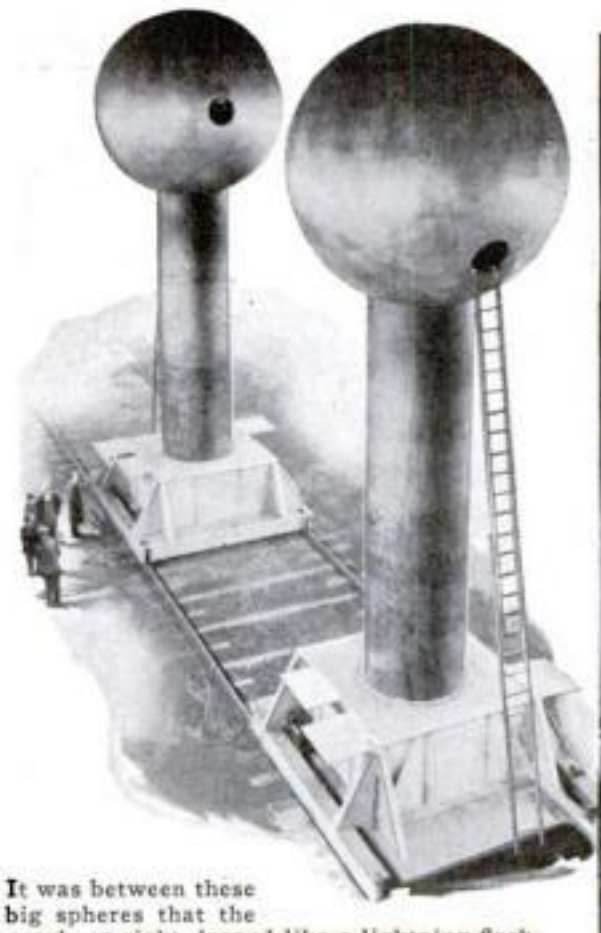
So THAT a car owner may have the radiator of his machine flushed or repaired, without losing the valuable anti-freeze compound that it contains, a special draining wagon has been introduced. Rolled beneath the outlet, it catches the outpouring liquid in a covered tank that is designed to prevent evaporation. When repairs are completed, the liquid is pumped back into the radiator, as shown in the illustration.

STIFFNESS OF MATERIAL TESTED BY MACHINE

COMPARING the relative stiffness of different samples of paper, fabric, and thin metals with precision, instead of by guesswork, is made possible by a testing device of new design. When a test strip is inserted and flexed by pulling a handle around the rim of the dial, as shown below, a brilliant pilot light flashes as soon as the specimen is bent to a standard angle. At this point the stiffness of the material, represented by the amount of deflection of a weighted pendulum, is read in stiffness units from a numbered scale on the rim of the dial. A built-in trimming board, with set gages for length and width, seen at lower right in the photograph, facilitates preparing test strips of the proper size. The device is sufficiently sensitive to measure the stiffness of tin foil only 1/100th of an inch thick.



Stiffness of material is indicated on this dial



It was between these big spheres that the spark, at right, leaped like a lightning flash

BIG GENERATOR CREATES LIGHTNING

GENERATED at the highest direct-current potential ever attained, crashing blue sparks of 7,000,000 volts leaped from the Massachusetts Institute of Technology's giant static machine recently in its first try-out. Operators sitting within the fifteen-foot spheres of polished aluminum controlled the man-made lightning playing about them. Later it will be harnessed in an attempt to break down the atoms of various elements. Even higher voltages are expected to be available when favorable weather conditions prevent leakage of the current. Because of its monster size, the electric machine is housed in a dirigible hangar, and its columns are wheeled toward or away from each other on rail cars when it is desired to create a spark.

Volcanic Islands Vanish

UNDER EARTHQUAKE BARRAGE

This volcano on the island of Whakari, in the Bay of Plenty, New Zealand, is again in violent activity. Its last great eruption occurred in 1914 at which time several sulphur gatherers lost their lives. Its present outburst is part of the general disturbance occurring in the Pacific

By
Petrie Mondell

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KRAKATOA, mightiest of modern volcanoes, is in action again. Quiescent for nearly fifty years since it startled the world with the most appalling eruption of history, this submarine volcano off the coast of Java, recently began to play strange tricks. Spouting steam and showers of lava, it suddenly jutted a solid cone above the waves—a new island among the East Indies. When waves washed the newborn land away, a second was thrust up, and this in turn was followed by a third. Now the fourth offspring of the volcano, the island Anak Krakatoa IV ("anak" is Malay for "child") has appeared and seems likely to remain.

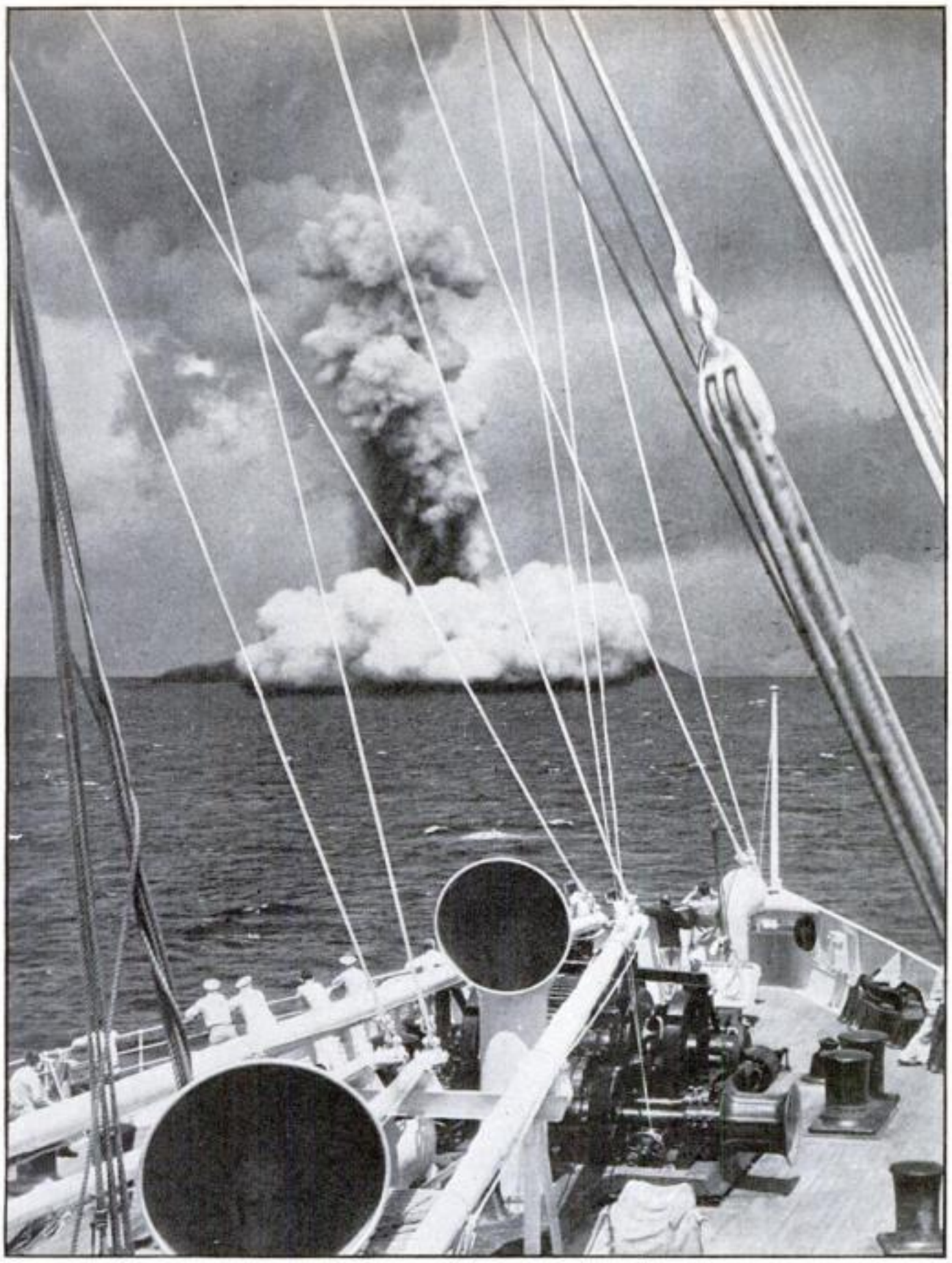
Far from being an isolated occurrence, the birth of a new island, amid rumblings and shiverings of the earth's crust, happens with surprising frequency. It occurs so often, in fact, as to plague geographers, who wish the world would hold still so they could map it. Mystery islands bob out of the sea from nowhere, remain in view a day or a decade, and then vanish as mysteriously as they came.

Scientists know they are the result of the folding and crinkling of the earth's outer shell under terrific internal pressure, punctuated by explosions when sea water, seeping through the ocean floor, meets the molten lava beneath. The appearance of a new island, together with seismograph records and an occasional devastating tidal wave, may give the only outward indication of cataclysms that occur almost daily somewhere at the bottom of the sea, showing that the evolution of the earth's contours is not yet finished.

Worldwide interest was aroused two years ago, for example, when the captain of the British steamship Lelande announced that he had sighted two new islands off the coast of

HOW ISLANDS ARE BORN IN THE PACIFIC

At top, a beach of black volcanic sand on a Pacific Island, a peculiarity of volcanic islands. Above, illustration showing the manner in which new islands are created in the ocean



On the island of Krakatoa, which lies between Sumatra and Java, the famous volcano, which has taken a toll of thousands of lives, is again in violent eruption and has formed new islands

Activity on Pacific's Floor Causes Swift Changes in Geography and Starts Vast Tidal Waves

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northern Brazil, several dozen miles distant from the charted rocks of St. Peter and St. Paul. Strong seismic shocks from the locality, detected at about the same time, indicated volcanic action had lifted the islands from the sea.

Experts weighed the possibility that the islands might offer to the first country to claim them landing places for transatlantic airplanes, and naval refueling stations. While France and England were pondering the advisibility of sending expeditions, the cruiser *Belmonte* of the Brazilian navy hastened to the scene of the discovery to take possession. Surveyors and geologists aboard the ship prepared to map the islands and determine whether they were likely to remain above water. When the *Belmonte* reached the reported latitude and longitude, however, no new land was to be found. The empty-handed scientists concluded that the islands, after their brief appearance, had sunk again beneath the sea.

Desiring information as to the best point from which an expedition could observe the coming solar eclipse of 1937, a German astronomical group consulted the U. S. Naval Observatory, and thereby elicited another story of a disappearing island. The spot picked as most favorable by the U. S. Naval Astronomer was a point in the Pacific Ocean corresponding to that of Sarah Anne Island, discovered in 1858 and claimed by an American guano firm. Unfortunately for the German astronomers, recent charts showed that Sarah Anne Island had vanished beneath the waves!

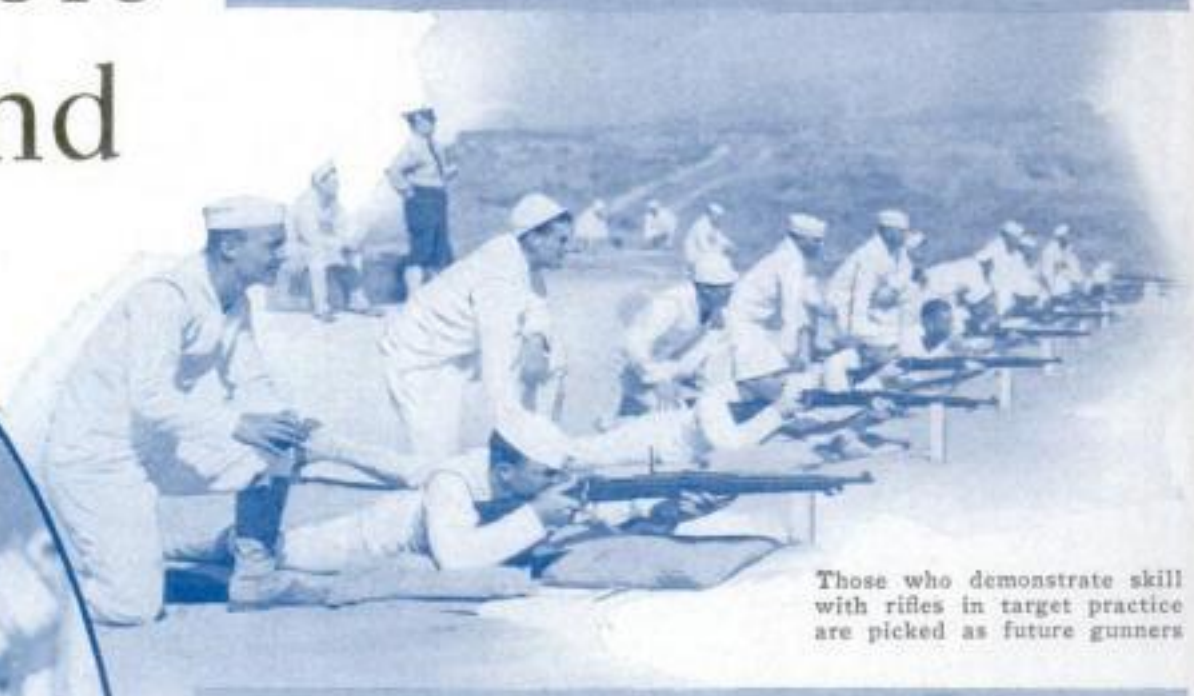
To naturalists, the appearance of a volcanic island is an unexpected stroke of good luck. It gives them an unparalled opportunity to observe the first appearance of plant and animal life on absolutely virgin territory, where no living thing has existed before. Thus W. Van Leeuwen, Dutch biologist, recently risked his life to visit the new island Anak Krakatoa IV, which a new volcanic outburst might overwhelm at any moment. He found and classified eight different kinds of plants that had germinated in the black sand from seeds washed ashore on the beach. The fact that he found seedlings of the coconut tree, settled a long-standing botanical controversy as to whether its spread occurred spontaneously by the sea route.

Since more than half of the earth's area is under water, and volcanic belts are not limited by coast lines or continental boundaries, submarine earthquakes and eruptions are daily occurrences in every part of the world, and sometimes reach the proportions of major cataclysms. A tidal wave caused by such a disturbance in 1925 threw the United States battleship *Maryland* on her beam ends, at Honolulu, and water poured in her upper ports.

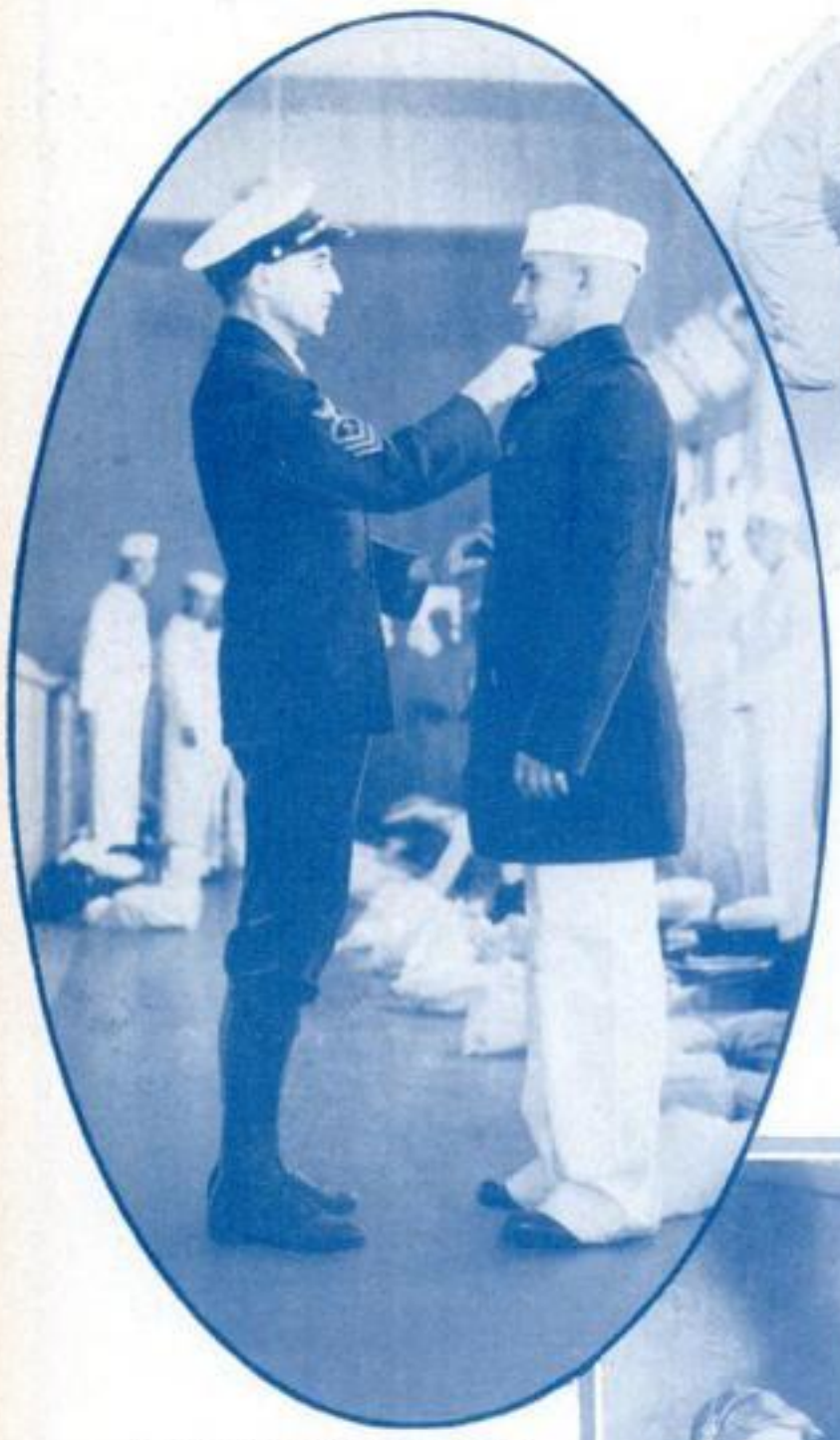
What it feels like to be in a ship directly over the scene of a submarine eruption is shown by the experience of the crew of an English ship cruising in the Mediterranean some years ago. They felt a shock as if the vessel had run aground, and a column of water 800 yards in circumference spouted sixty feet high, followed by clouds of steam reaching an altitude of a quarter of a mile.

Five days later a small island appeared on the spot, which later grew until it measured three miles in circumference. Months later, the waves eroded it and it disappeared. Other cases of volcanic islands resembling this classical example have been reported from all parts of the globe, especially among the Aleutian islands of Alaska and islands of the Pacific.

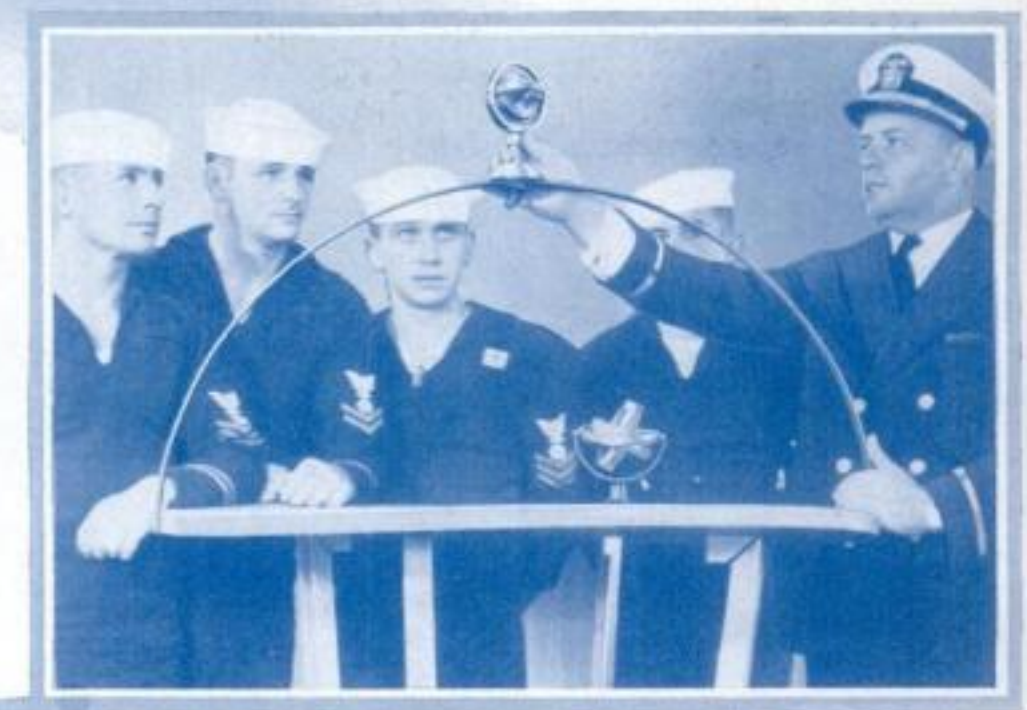
How the NAVY Trains Sailors on Dry Land



Those who demonstrate skill with rifles in target practice are picked as future gunners

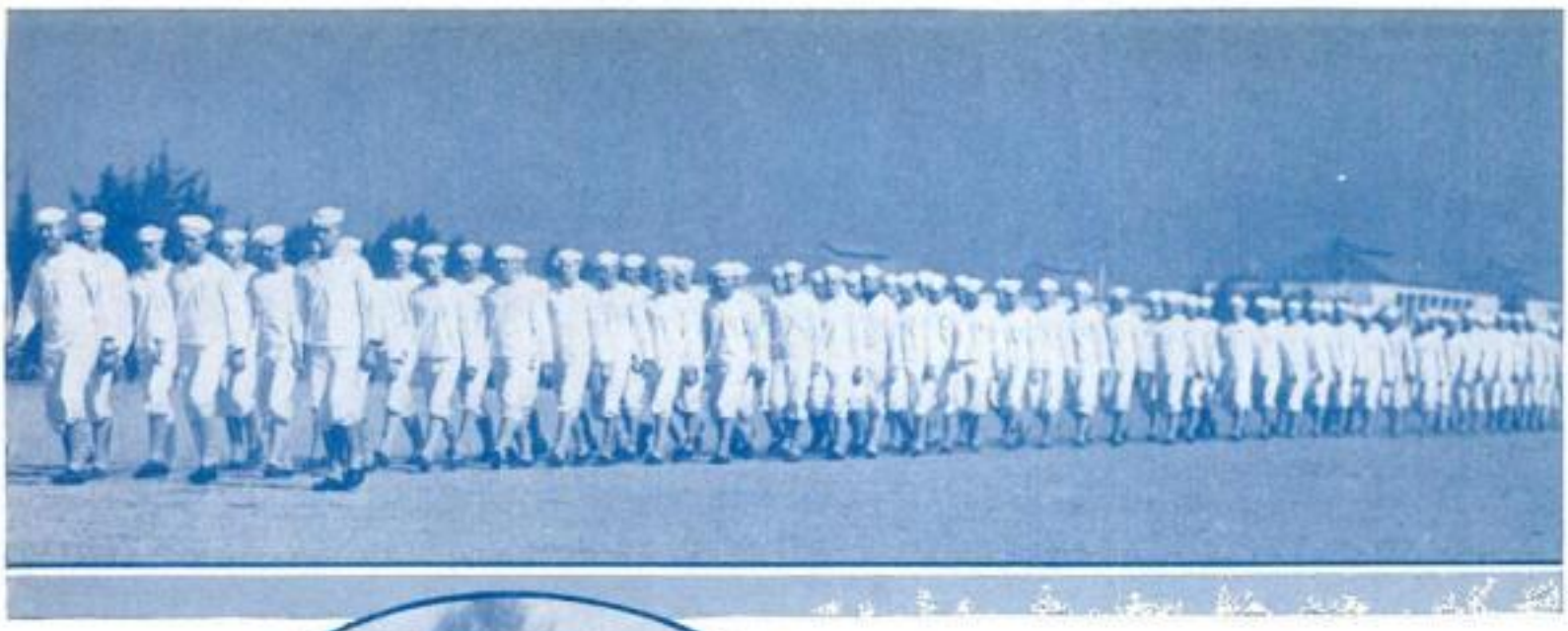


It takes only a few minutes to convert a civilian into a gob —in appearance, at any rate. A well-fitting uniform of white and the regulation Navy pea-jacket bring about the transformation



The men above are a class in gyro dynamics. They are learning the theory of gyroscopes with small models before beginning the actual study of the real gyro compass

No sailor becomes a radio operator without passing the test shown at the left. A phonograph emits dots and dashes in a constant stream, and the accuracy with which the recruit jots them down indicates his aptitude for radio



Yesterday they were farm boys, or jobless on the streets. Today they swing by their instructors at a Naval training station as though they had been drilling for months. Already they have put behind them the habits of civilian life. Below, one of several adaptation tests by which the Navy selects men for specific jobs.

Here the recruits are having their first introduction to life aboard a ship. Though sail is no longer carried in the Navy, they are being taught to tie standard knots and to splice with ropes fixed to a jack stay

An enlisted man, found by tests to be of superior mentality, studies the gyro compass at a Naval training school

ONE thousand eager young men, from farms, ranches, and cities, file through the gates of a naval camp. Three months later they emerge highly skilled in the sciences of war and seamanship.

Such is the procedure at the United States Navy's newest sea colleges at San Diego, Calif. and Hampton Roads, Va.

In these two modern training stations, buildings and laboratories replace the training ship and rigid tests supplant haphazard judgment. Apprentice sailors no longer climb masts, and man big guns. Instead, in the classroom, expert instructors acquaint them with the gyro compass, the range finder, radio, sound movies —everything mechanical that enters into life aboard a ship. Officers catalog each recruit according to his abilities and failings.

Will he go to a destroyer, aircraft carrier, submarine, cruiser, or battleship?

To China, Hawaii, Canal Zone, Atlantic seaboard, or west coast?

Is he a potential turret captain, gunner's mate, ship fitter, machinist, blacksmith, bugler, radioman, or aviation mechanic?

Psychological tests reveal quickly where the individual belongs.

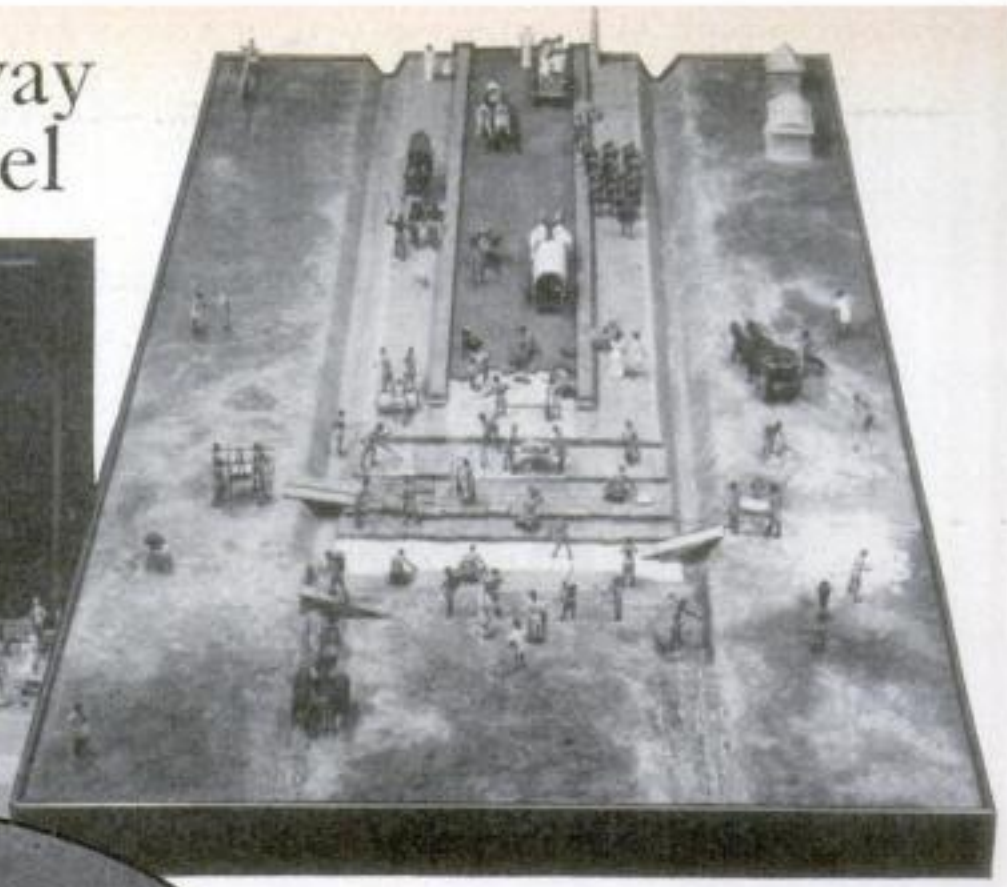
One hundred and forty youngsters crowd into a classroom. An instructor passes folded papers. On each is a series of questions. A magnet attracts . . . copper . . . brass . . . iron? The recruits circle the correct word. A balloon is filled with . . . what? The boiling point of water is . . . what? The answers reveal the recruits' knowledge of things mechanical, physical, and chemical.

Successful candidates indicate their preference for radio work, for engineer artificer, deck artificer, machinist's mate. On the basis of their grades and preferences they are then tested further.

Will Bill Jones make an expert radio operator? That question is answered via a phonograph record. Bill and his mates sit along the two sides of a table having recesses fitted with earphones and sending keys. From a phonograph comes a series of dots and dashes, first slow and then fast. Each candidate marks the sounds down just as he hears them.

Another test, consisting of irregularly shaped blocks that must be fitted into odd-shaped holes, rapidly measures each recruit's mechanical ability. Again, on the rifle range, target practice indicates the men best fitted to be gunners.

Rome's Great Highway Reproduced in Model



Experts of the U. S. Bureau of Public Roads, above, constructing their remarkable model of the Appian Way. In oval, model showing how tourists traveled the great highway in Cæsar's time. At far right, slaves dragging a road roller over a partly completed section of the road. Note, various layers in its construction

Here is the Government's finished model of the highway, the details being accurate in every particular

ONE of the world's most famous highways, the Appian Way, that connected ancient Rome with its seaport in the time of Julius Cæsar, has been recreated in miniature by experts of the U. S. Bureau of Public Roads. Replete with tiny figures of chariots, soldiers, wagons, and chair-bearers, the remarkable model shows what a traffic scene was like twenty-three centuries ago. It also reveals how the huge engineering task of building the 430-mile highway was carried out. Surveyors are shown plotting the route of the highway with their crude instruments, while an uncompleted section at one end of the model shows the successive layers of cemented stones, mortar and sand, gravel and lime, and lava slabs of which it was made. To insure the accuracy of the model in the smallest details, three Government experts pored for six months through volumes of early Roman records and engineering treatises, including rare Latin manuscripts lent by leading universities for the purpose.

POWER FUSE HAS HANDLE

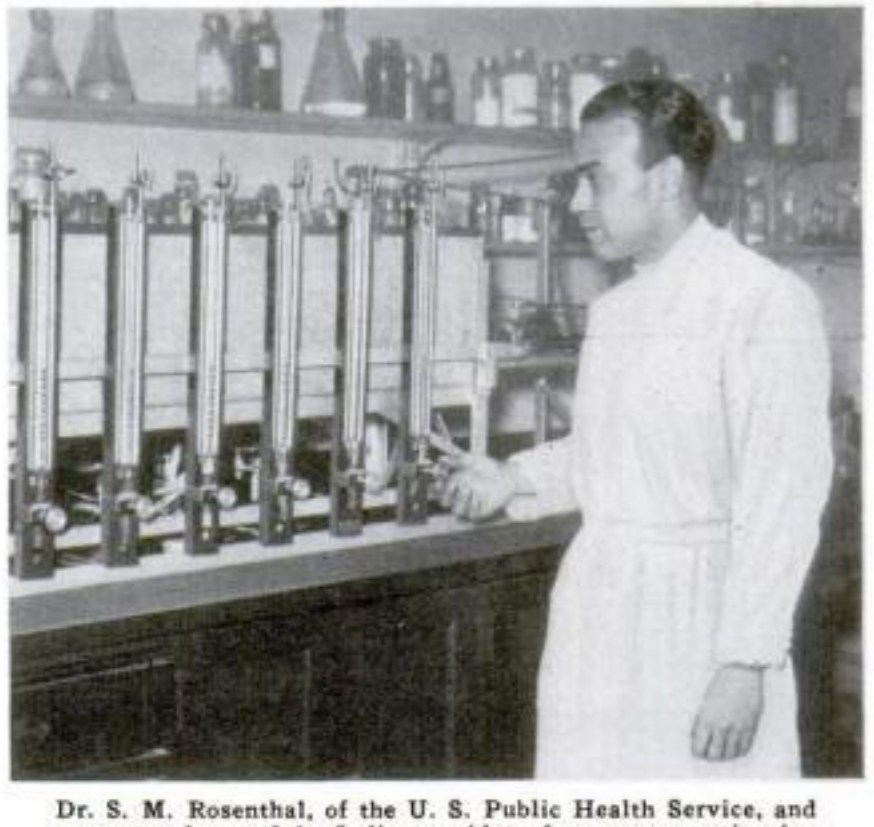
REPLACING a blown-out cartridge fuse in a power line is made safer by the introduction of a new type of fuse, provided with an insulated handle. By this simple means, the fingers are protected from contact with live conductors, when a fuse is snapped in or out.

ELECTROCUTED SQUIRREL SHORT-CIRCUITS PLANT

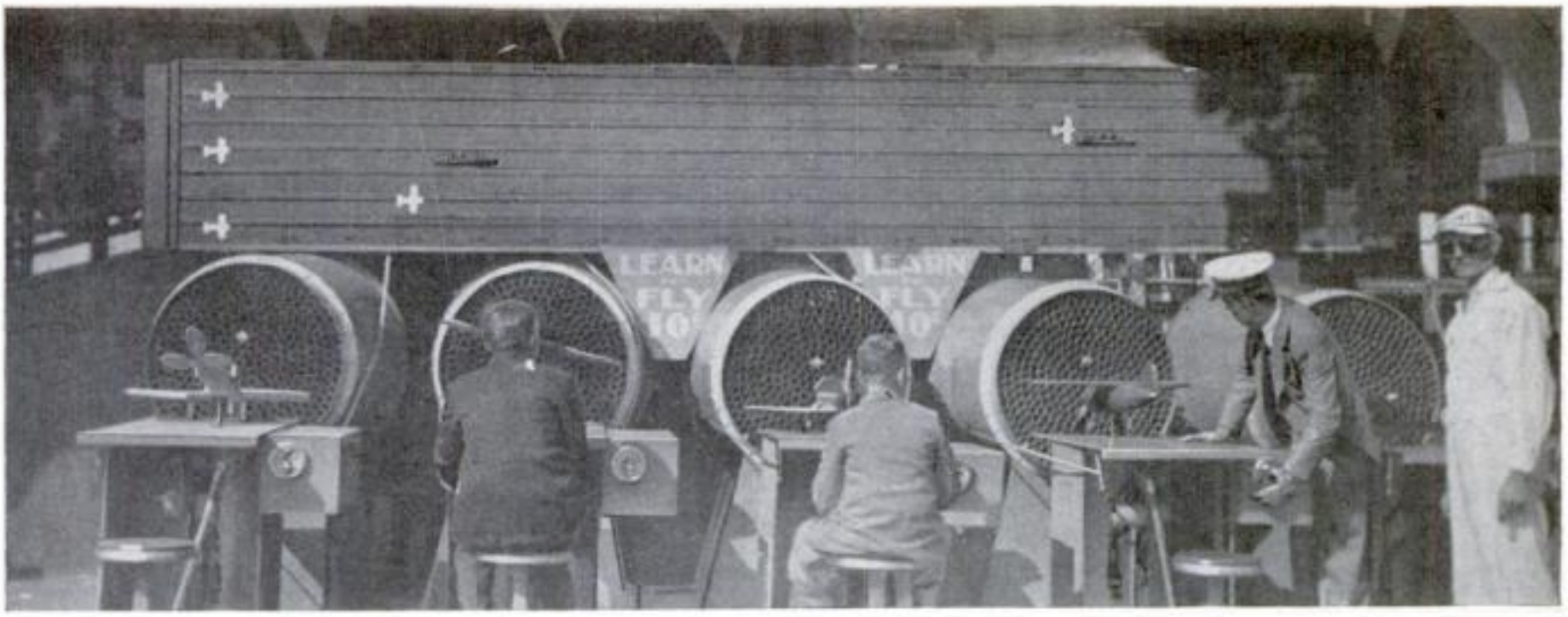
WHEN a squirrel tried to jump across a gap between two 11,000-volt transformers at Fond Du Lac, Wisc., recently, it caused damage which required three weeks for a corps of electricians to repair. The arc caused by its body melted porcelain insulators and steel and iron supports.

DRUG SAVES FROM MERCURY POISONING

ACCIDENTAL deaths from swallowing bichloride of mercury tablets, taken in error for medicine, may largely be prevented by a new and valuable antidote for this poison discovered by a U. S. Public Health Service pharmacologist. The new chemical, which bears the formidable name of formaldehyde sulfoxylate, is a compound of sulphur. Its potency as an antidote was revealed when Dr. S. M. Rosenthal, the discoverer, tried it on specimens of living tissue in his laboratory at Washington, D. C. Tests upon animals were satisfactory.



Dr. S. M. Rosenthal, of the U. S. Public Health Service, and apparatus he used in finding antidote for mercury poisoning



EXCITING WIND-TUNNEL GAME TEACHES PLAYERS TO FLY

ENTERTAINMENT and instruction are combined in an exciting aviation game devised by Assen Jordanoff, veteran pilot, whose articles on flying have appeared from time to time in this magazine. Each of the contestants sits before a miniature wind tunnel, as shown above, and attempts to keep a model plane on an even keel in the breeze by manipulating standard aircraft controls. As long as he is successful, a toy plane, propelled by an electric motor behind the scenes, travels steadily across a board at the rear. The moment the model craft tips or swerves, however, a contact is broken, and the toy plane on the board halts until the player has righted his machine. By operating several of the models simultaneously, two or more players can stage a thrilling race across the board, which is decorated to represent a trans-atlantic airway.

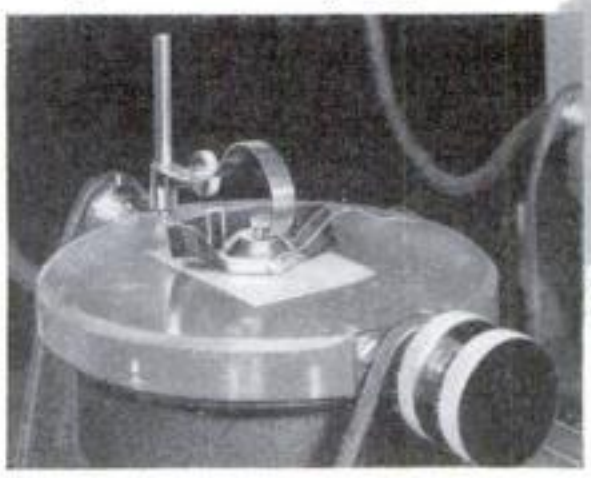
TESTER OF SHEET METAL WORKS IN BENCH VISE

OPERATED simply by placing it in a bench vise, and closing the vise, a compact new tester forces a rounded punch against a specimen of metal until a crack forms. A gage attached to the device records the load that the metal will stand.

AMPLIFIER GIVES WATCH LOUD TICK

AMPLIFYING the tick of a tiny watch to mighty volume is the feat of an electrical device developed by Bell Telephone Laboratory engineers for a New York jewelry firm. By listening to the magnified sound, the condition of the works may be ascertained. A watch, placed on a circular plate of insulating material, acts as one plate of an electrical condenser, while a small nickel-silver disk serves as the other plate. A loudspeaker amplifies the vibrations.

Below, a spring clip holding a watch in place on disk of amplifying device



With this apparatus, a watch is regulated by amplifying its tick so it is heard simultaneously with that of a master watch

CROOKS GRAFT NEW SKIN OVER FINGERTIPS TO HIDE IDENTITY

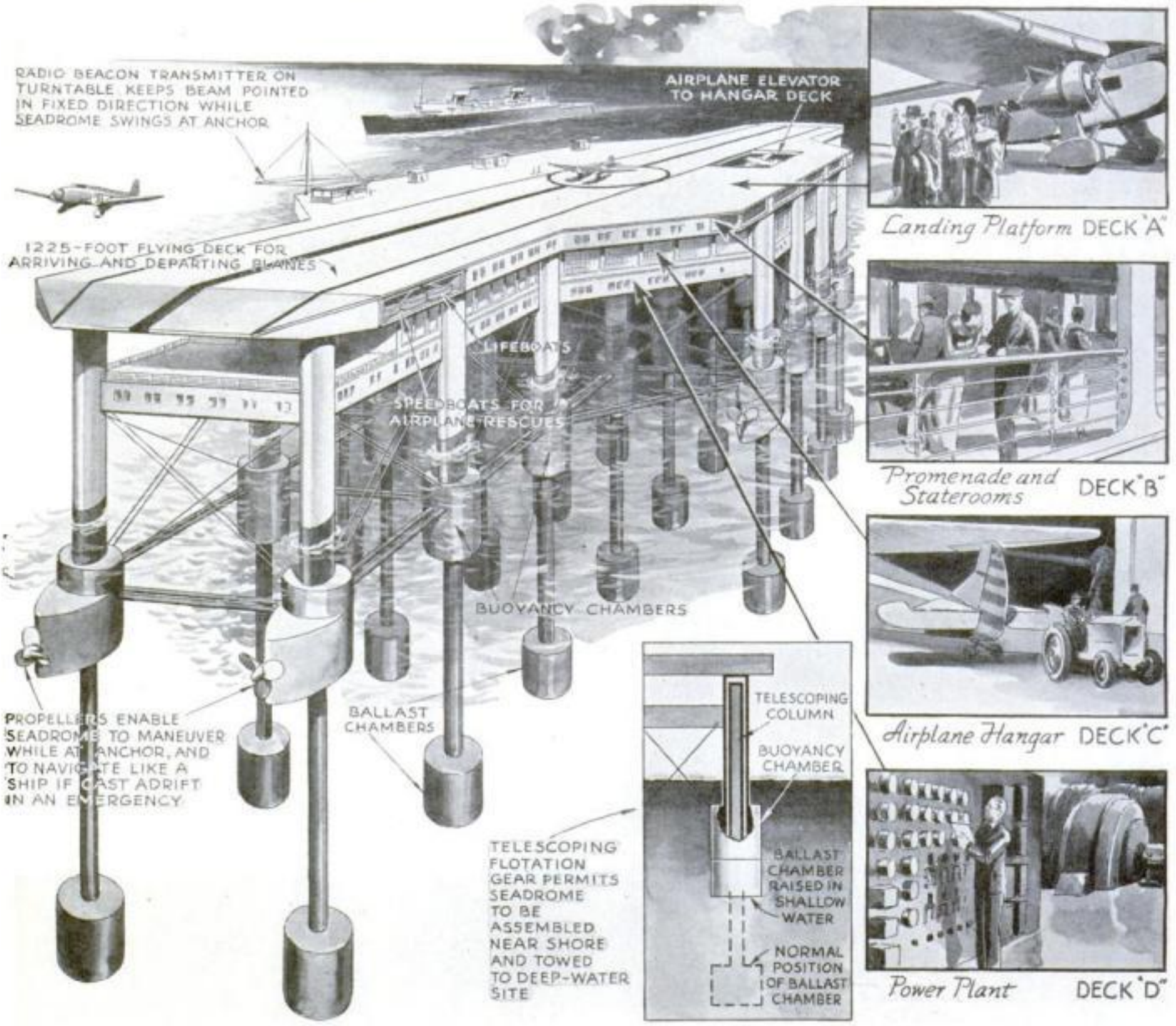
CAN a criminal change his fingerprints? Illinois police officials recently were confronted with this problem, when attempts to fingerprint two bank robbers produced only smudges. According to Dr. Leonard E. Keeler, of Northwestern University's crime detection bureau, it would be possible to graft skin from another part of the body on the fingertips, through a painful operation, and previous prints would then become worthless. Should the underworld generally adopt such strenuous measures, it would be a staggering blow to the nation's machinery for detecting crime, since fingerprints are considered to afford the best means of identification. The largest collection belongs to the Federal Bureau of Investigation.

AUTOMATIC FIRE ALARM DESIGNED FOR THE HOME

SO SIMPLE to use that it may be installed anywhere at a moment's notice, a new fire alarm for the home, illustrated at left, is screwed into any electric socket like an ordinary lamp bulb. Should the temperature of the room begin to rise at the rate of ten degrees a minute, a sensitive diaphragm closes an electric contact and an intermittent howler shrieks the alarm. If desired, an extension cord to a second howler in a bedroom or upper hall may be attached to the alarm to make sure it will be heard.

UNCLE SAM ASKED TO BUILD

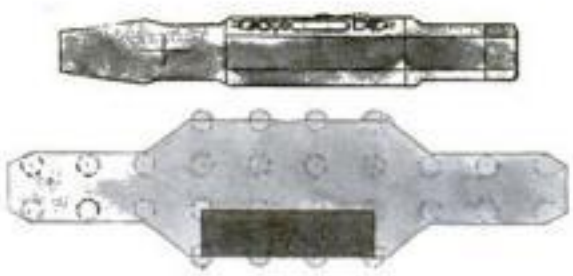
Floating Ocean Airports



This illustration shows the design and construction of the latest model of the Armstrong seadrome which the Government recently was reported ready to try out. Note the arrangement of the four decks

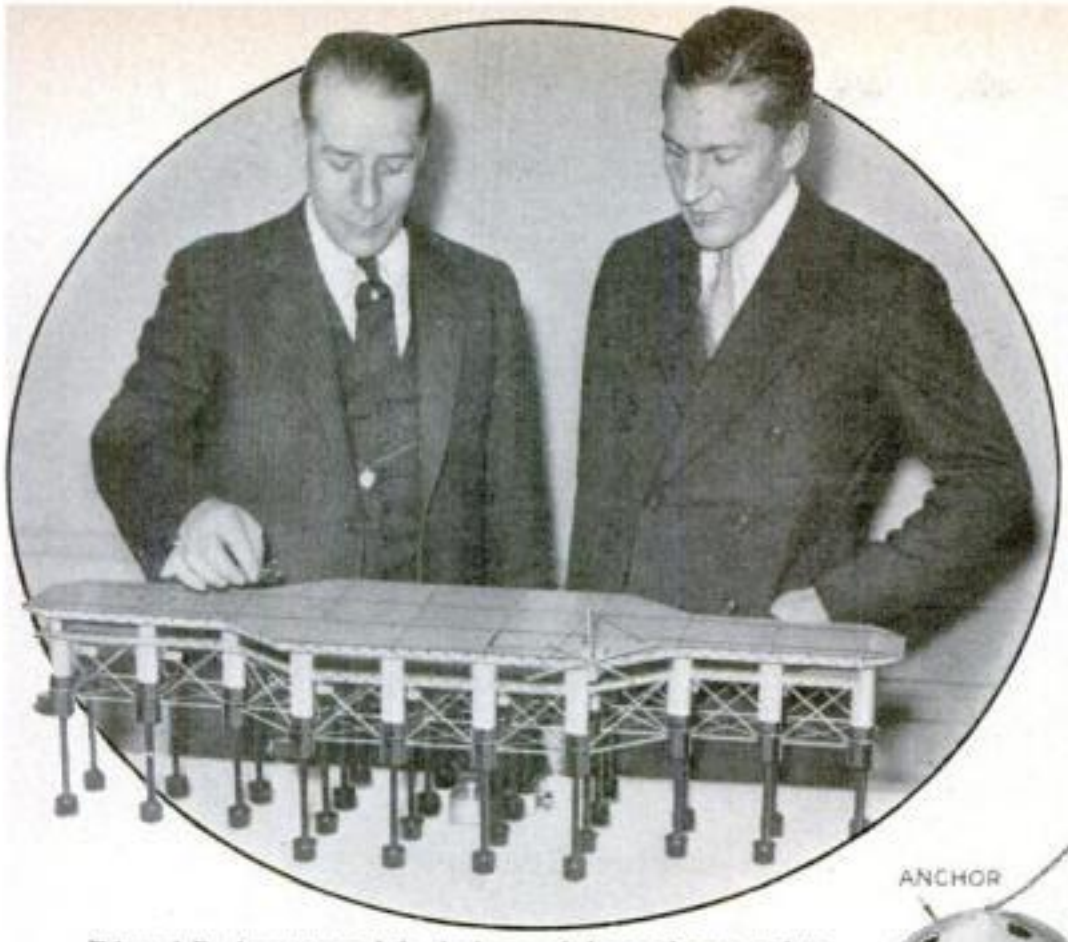
REDESIGNED and improved since its earlier forms were described in this magazine, a new type of "seadrome" or floating airport, is proposed by its inventor, Edward R. Armstrong, as the basis of a modernized plan to bridge the Atlantic with a string of artificial islands. His project, which has attracted the interest of U. S. Government officials, is intended to provide twenty-hour airplane service between America and Europe. It calls for the anchoring of five of the seadromes between America and Spain, at about the latitude of Washington, D. C., to serve as refueling stations about three hours' flight apart. Planes using these islands in stepping-stone fashion could transport heavy pay loads at high speed, since their loads of gasoline would be light.

On these pages our artist shows the details of the latest type of seadrome proposed by Armstrong, in seeking Federal aid for his project. The 1,225-foot airplane landing platform, supported 100 feet above the water on twenty-eight submerged buoyancy tanks, would not pitch and toss in stormy weather, Armstrong declares, because its supporting buoys float beneath the area of the sea that is subject to wave motion and its openwork structure allows waves to pass unhindered beneath its decks. These facts he has verified by experiments with models up to thirty-five-foot size. Each seadrome would have overnight accommodations for 100 travelers, in addition to quarters for its own crew and hangar space for fifty large transport planes. Run like a ship, the seadrome would have a captain, first officer, second officer, seamen, and engineers, as well as two meteorologists and a physician.

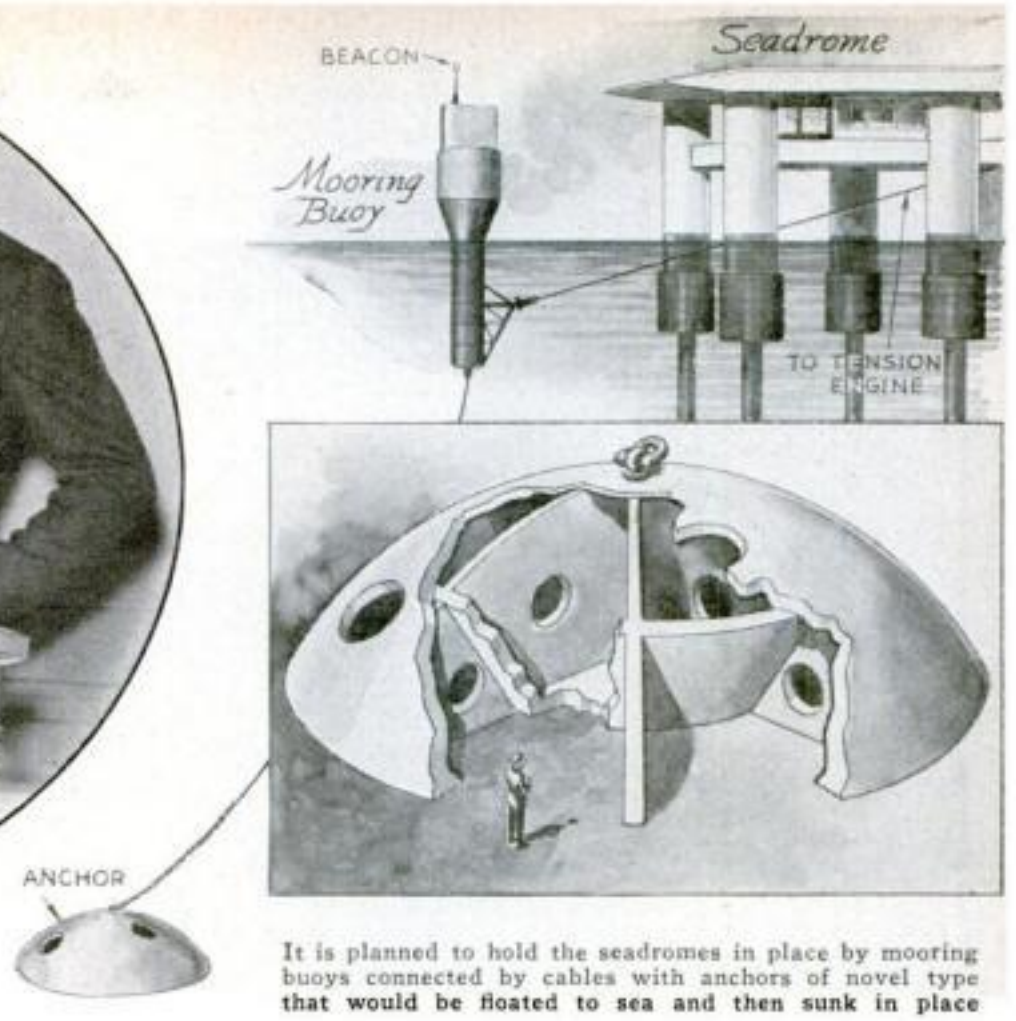


Landing area of seadrome compared with that of an aircraft carrier. Shaded section shows the first part that will be built

Any type of plane—land plane, seaplane or flying boat—could use the seadromes as refueling stations, although Armstrong himself believes that a special-



Edward R. Armstrong, left, designer of the seadrome, points out some of its principal features to Eugene L. Vidal, director of aeronautics of the U. S. Department of Commerce



It is planned to hold the seadromes in place by mooring buoys connected by cables with anchors of novel type that would be floated to sea and then sunk in place

ized type of amphibian plane will be developed for this purpose. Aircraft will be guided to the island airport by a standard type of radio beacon, which is mounted on an automatic turntable controlled by a gyro compass. No matter how the seadrome may swing at anchor, the beam will always point in a fixed direction. Another innovation not found in his earlier plans is an emergency propulsion system that enables the seadrome to navigate like a ship if it is necessary to cast the seadrome adrift to ride out a storm of phenomenal severity, or if it should break loose from its moorings. This is provided by four propellers, each operated by a 500-horsepower electric motor that is supplied with current from the seadrome's gasoline-electric power plant.

To anchor his seadrome, Armstrong proposes to float a 1,660-ton anchor of steel and concrete to sea, and sink it on the selected site by opening ports that allow water to rush into its inner chambers. Heavy steel cables moor the seadrome to a buoy that, in turn, is attached to the anchor. A tension engine on the seadrome takes up the slack on the cable so that it will not foul the understructure, paying it out automatically in response to a sudden strain.

Present plans call for a section one-fourth the size of a finished seadrome to be built and anchored at sea for final tests, including attempts to land upon it with a plane. If these are successful, the Government may be sufficiently interested to take over the project and build and operate the whole seadrome chain itself. Experts in international law believe the United States would have a right to anchor the islands on the high seas.

Builds Odd Land-Ship for Duck Hunting

AUTOMOBILE and boat are combined in a curious "land ship" built by Emil Johnson, of Salt Lake City, Utah. Driven by an air propeller, it is said to attain sixty miles an hour on land and forty miles an hour in the water. For aquatic use, the three rubber-tired wheels are raised and the vehicle floats upon its watertight hull. Because of its shallow draft, the inventor believes his machine would prove of service in duck hunting, and would enable a hunter to drive home after a day's outing.

At right are two views of an amphibian vehicle. One shows it on land, the other as a water craft

• Facts about Flying

Ring Around the Motor Pulls the Plane Ahead

1 THE TOWNEND ring around a motor increases the speed of a plane because it actually pulls the machine ahead during flight. If the ring were placed in a slipstream by itself, it would blow backward; but when it is placed around the motor it pulls ahead. The explanation lies in the fact that the metal ring is really a lifting surface with a cross section similar to an airplane's wing. The front of the ring has a smaller diameter than the rear so the effect is that of having a lifting surface all around the motor which is tilted forward. The air currents, hitting the flat face of the motor, are deflected radially and strike the ring at such an angle that the resulting lift is forward. The stronger the currents, the greater the forward lift or pull exerted by the ring.

Slipstreams Funnel-in Behind Propellers

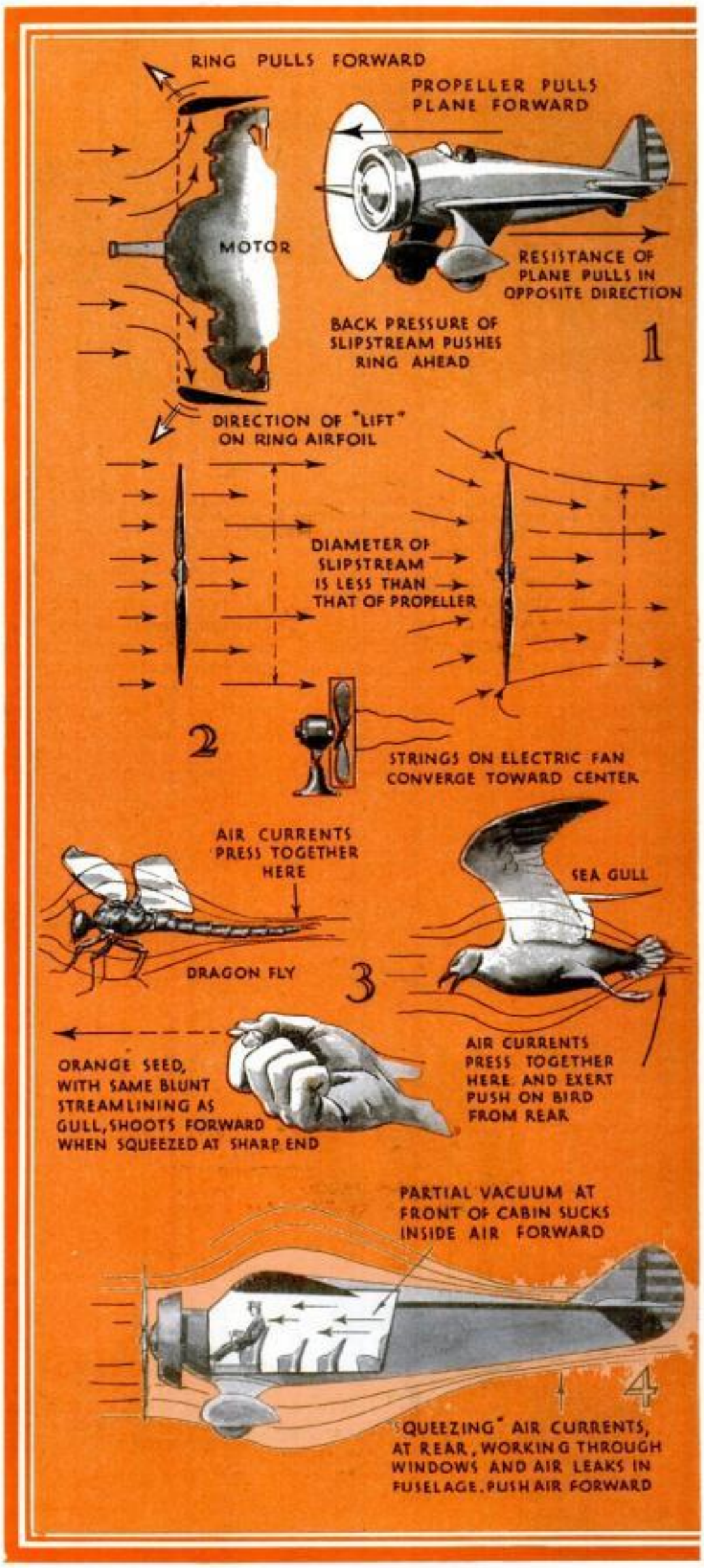
2 CONTRARY to common belief, the slipstream, or blast, sent back by the propeller, does not spread out behind the whirling blades. Instead, it contracts, or funnels-in, back of the tips so the diameter of the slipstream is less than the diameter of the propeller. As the blades suck air from in front, other air rushes in from all sides to fill in the hole. Thus it is drawn in from an area of greater diameter than the circle of the blades and this side air, coming in at an angle, compresses the other air toward the center of the slipstream. Strings tied to the frame of an electric fan illustrate this as they fly at an angle to the center of draft.

Gull Better Streamlined Than a Dragon Fly

3 IF YOU have ever shot an orange seed across a room by squeezing the pointed end, you have demonstrated why the body of a gull is better streamlined than that of a dragon fly. In a stubby, streamlined body, like a gull's, the bulging forward part deflects the air currents outward so they come back, squeezing together near the rear. In the long darning-needle body of a dragonfly, the air currents come together nearer the head. The same principle holds true in airplanes. Thus the new navy dirigible, *Macon,* is better streamlined than the old *Los Angeles* because its length is less in proportion to its diameter.

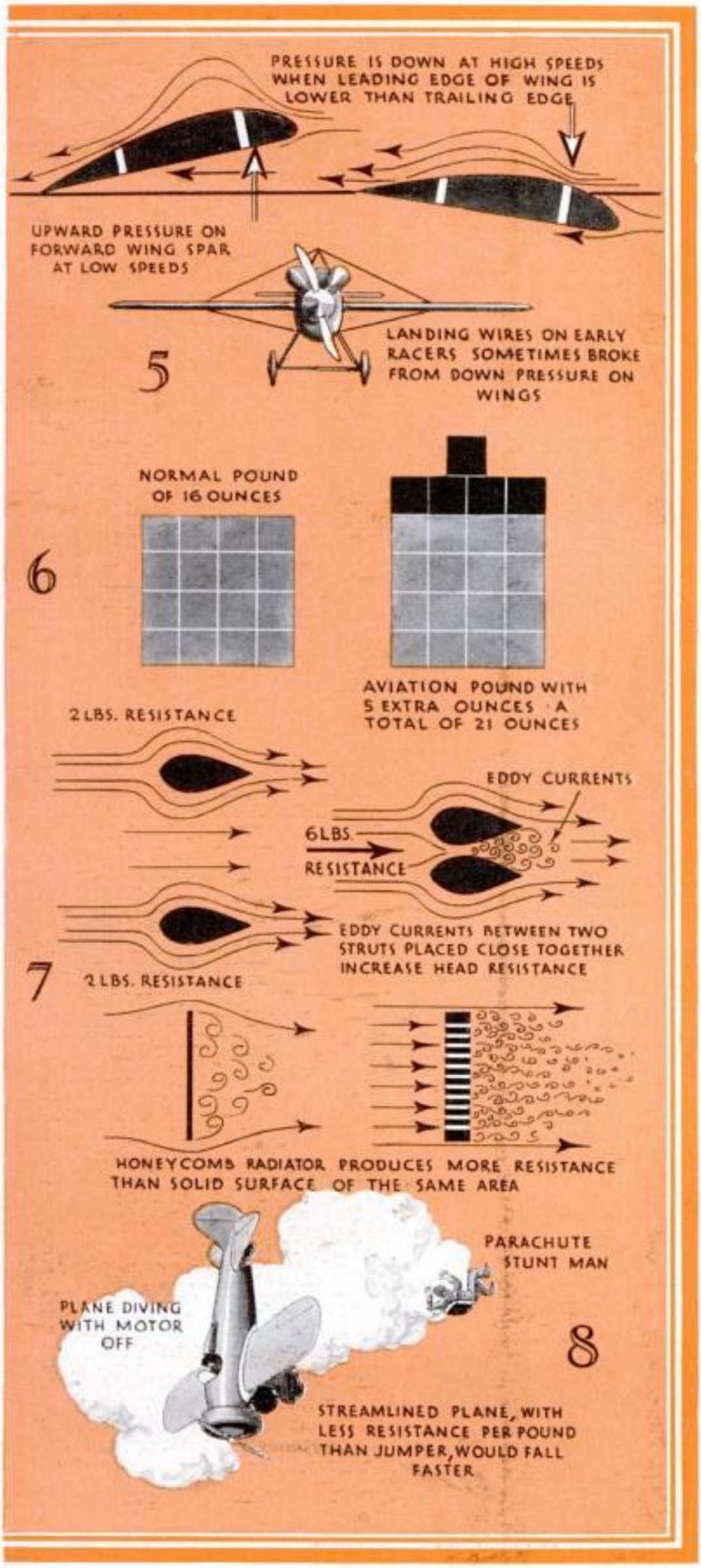
Draft in an Airplane Cabin Blows Forward

4 IN THE cabin of an airplane, although a gale rushes past to the rear at two miles a minute outside, there is usually a draft blowing forward against the wind. The explanation is that the airstream is deflected by the fat part of the streamlined fuselage, just behind the nose, so a suction is formed, similar to that which gives lift to the top of the wing. Further back, these air currents press down again against the sides of the fuselage. Thus, the suction in front and the pressure behind pump the air forward in an opposite direction to that in which the plane is traveling.



By CAPT. FRANK T. COURTNEY

Few People Know



At High Speed, Pressure on Wing's Front Spar is Down

5 During trial runs at top speed, the wings of a number of early planes broke downward in the air. The cause was a mystery until tests revealed that when high-speed planes fly wide open, the pressure on the front spar of the wings is often down. At peak speeds, powerful ships, with lightly loaded wings, fly with the leading edge of the wing lower than the trailing edge. Most wings will lift at a negative angle of from two to six degrees. In this position, the wing is struck by the head-on wind on the top side some distance back from the leading edge. This pushes down the forward part of the wing and shifts the partial vacuum area back toward the rear spar. Consequently, at great speeds, the pressure on the front spar is actually down instead of up.

In Aviation One Pound Equals Twenty-One Ounces

6 For every pound added to the carrying capacity of an airplane, designers calculate they must add five ounces to the weight of the structure to make it strong enough and large enough to carry the extra load. A little bigger wing is needed to support the extra pound; a bigger engine to push the larger wing through the air; added gasoline to feed the larger motor; bigger fuel tanks to hold the extra gasoline. Consequently, when the carrying capacity of a plane is increased one pound, the added load it must lift into the air will be, not sixteen ounces, but twenty-one. Inversely, cutting the weight of the machine one pound, saves a pound and a third.

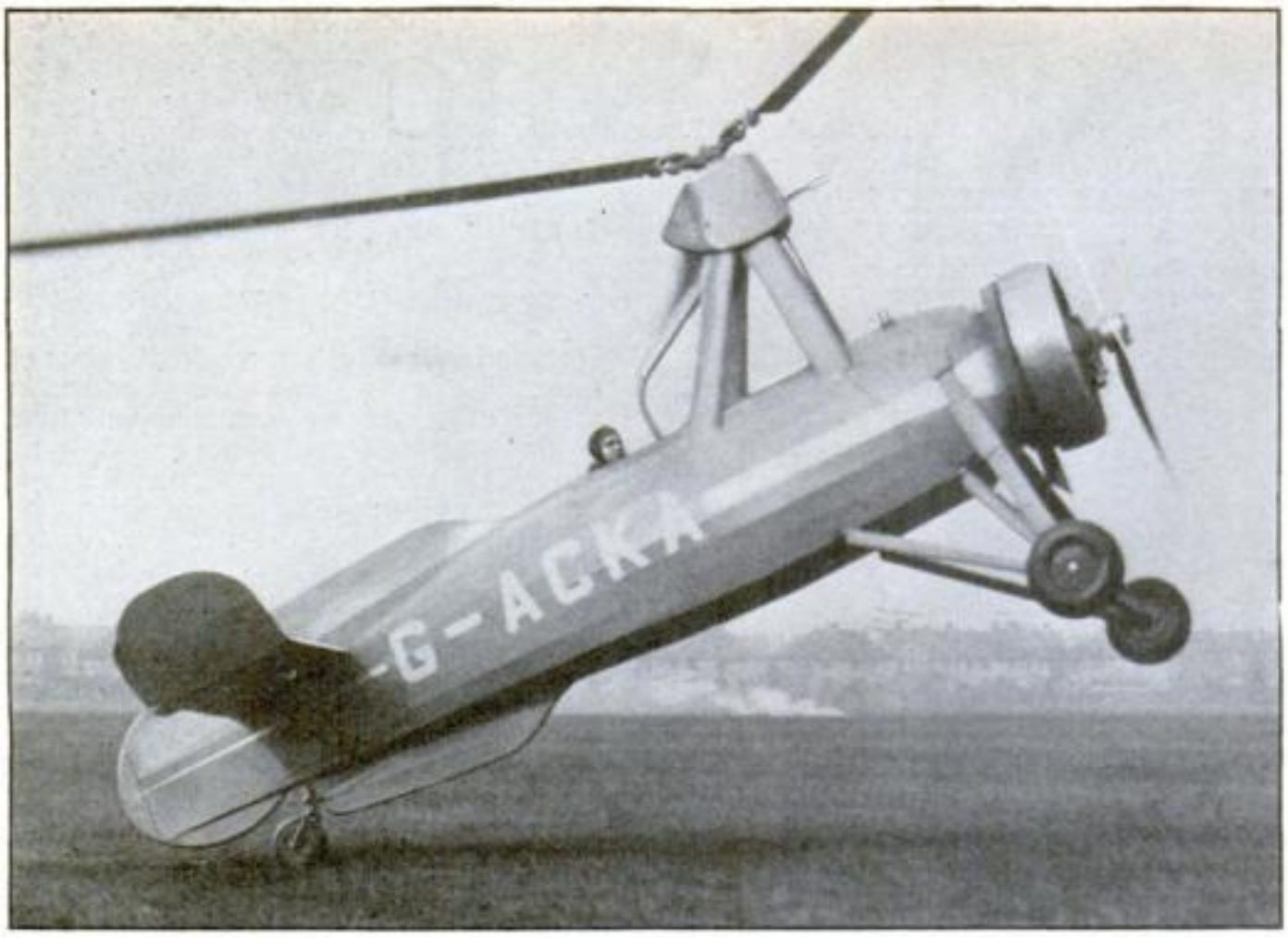
Two and Two Equal Six in Aviation

7 If two streamlined struts, each having two pounds' resistance in passing through the air, are placed near together, their combined resistance will not be four pounds. It will be sometimes six pounds or more. The reason is the air flow around one strut interferes with the air currents passing around the other. Eddies are formed between the two, increasing the drag. Planes with twin bodies or closely placed hulls, have often proved inefficient due to such interference drag. Designers try to keep wings, struts, and fuselages from interfering with each other as much as possible. In fact a honeycomb radiator produces more resistance than a flat surface of the same area because each little tube produces interference.

A Falling Plane Would Pass a Falling Body

8 If a stunt man, making a delayed parachute leap, jumped from a plane high in the air, the pilot, diving with the engine off, could drop faster than the jumper. On both objects the pull of gravity would be the same. But the falling man would not be streamlined while the plane would be. Consequently, the airplane, with less resistance in proportion to its weight, would travel faster with the same pull of gravity.

Famous Test Pilot and Designer



New wingless autogiro, caught by the camera as it was making a spectacular landing at the conclusion of its first public test flight, which was recently made at Hanworth, England

New Wingless Autogiro Gets First Test

CAUGHT by the camera in a spectacular, near-vertical landing, the new type of autogiro illustrated at the left is the latest creation of Senor Juan de la Cierva, whose previous types have already made aviation history. The latest model is wingless, depending for support in the air entirely upon the huge four-bladed windmill that revolves in the breeze during flight. Control of the plane is maintained through the tail surfaces, which are of unusual size. The radical machine was put through its paces for the first time in public in a recent demonstration over Hanworth, England and is reported to have performed satisfactorily at that initial test.

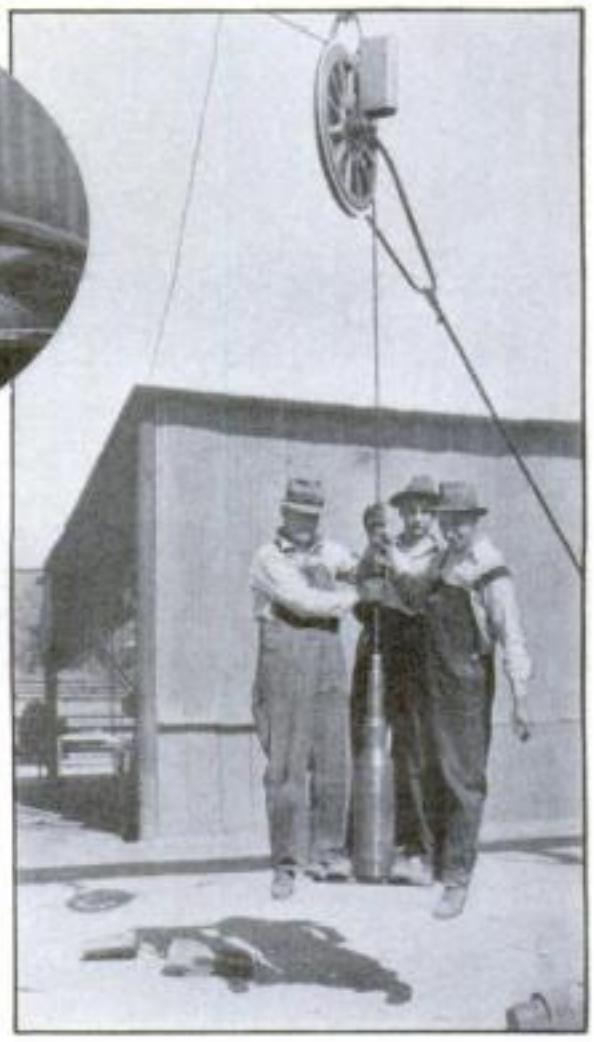
MINE-RESCUE WORKERS TRAIN IN GAS CHAMBERS

STUDENTS of mine-rescue work may receive training of a practical sort at Birmingham, England, where university classes in this science have been opened. Lying within small gas chambers, the students breathe through gas masks, while ammonia vapor, or sulphur dioxide gas, is admitted to the chamber. In this way, they learn to adjust their masks in the proper way to protect themselves from gas, without being exposed to the perils of less easily detected gases that are encountered in mines. The exercise also serves as a test for the gas equipment.

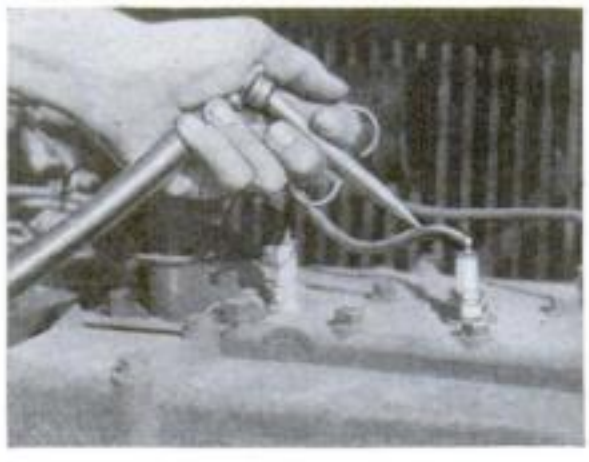
In these gas-filled chambers, students of mine-rescue work learn, under practical conditions, the best way to adjust their masks

MAGNET PULLS BROKEN TOOLS FROM OIL WELLS

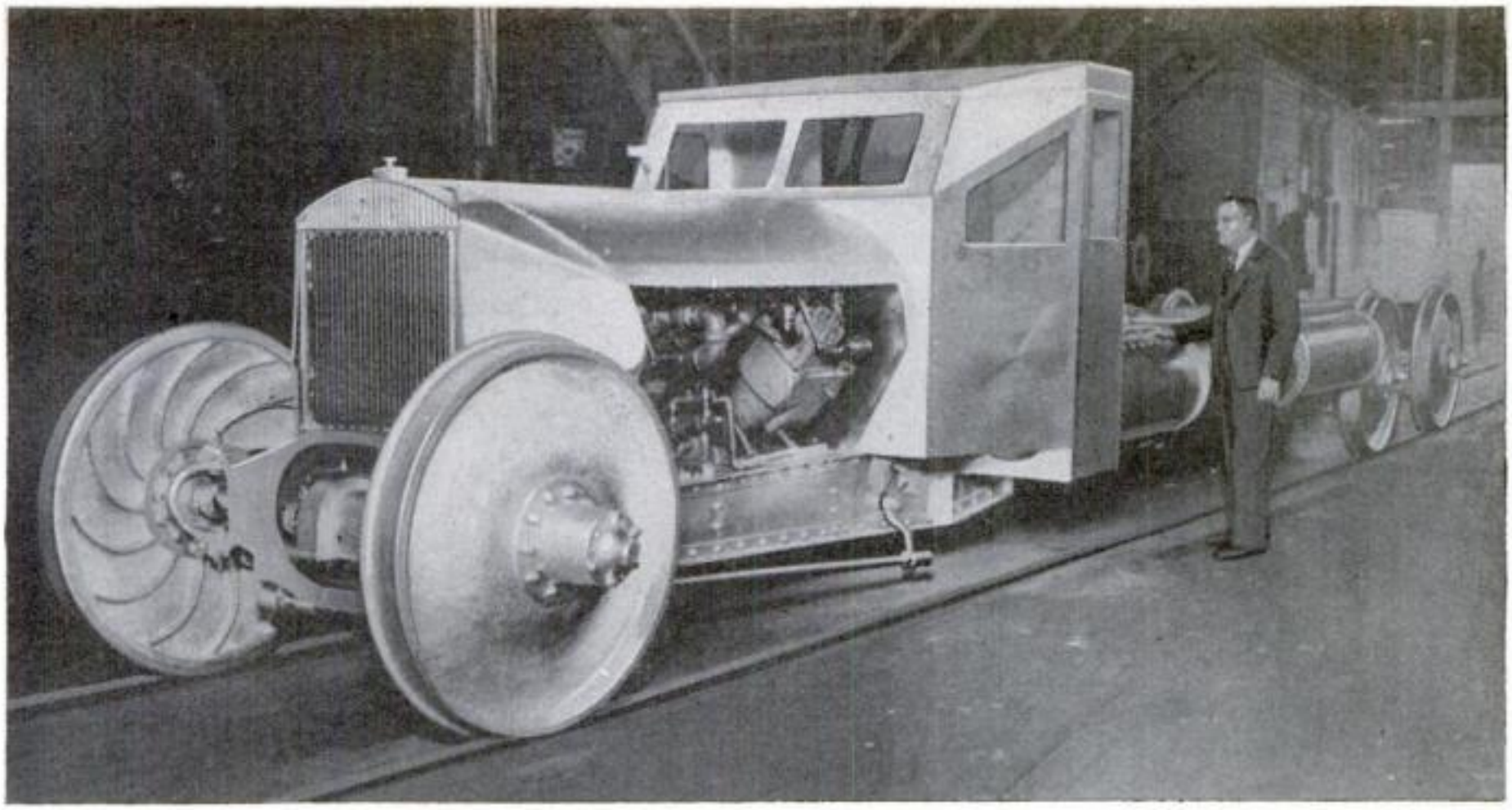
FISHING broken tools from unfinished oil wells, so that drilling can proceed, is the task performed by a giant electromagnet recently invented for the purpose. Cylindrical in shape, the magnet is powerful enough to support a bar holding the weight of four men, as shown at right. Lowered into the shaft by an armored cable, the magnet seizes fragments of tools and brings them aloft. Some of the pieces it has recovered, at depths of a mile or more, are shown above.



CLEANING HAND NOZZLE FITS AIR HOSE



ODD jobs of cleaning around a garage are made easier by a new hand nozzle designed to be used with the air hose. When the nozzle is held in the hand against the chuck of the hose and the finger loops are pulled, a powerful, concentrated blast of air spurts from the tip. The air jet provides an effective means of cleaning spark plugs, blowing oxide from battery terminals, blowing out plugged gas lines, removing dust and dirt from tires, and cleaning off rugs and upholstery in a car.



COMPRESSED AIR DRIVES LOCOMOTIVE 125 MILES AN HOUR

WILL steam power give way to compressed air for driving locomotives and hauling fast passenger trains? That is the vision of William E. Boyette, of Atlanta, Ga., whose amazing challenge to the iron horse—a monster truck-shaped locomotive propelled by compressed air—was about to undergo a trial run between Atlanta and Jacksonville, Fla., at this writing. The forty-foot locomotive, illustrated above, is designed to attain a maximum speed of 125 miles an hour. Its power is obtained from air compressed to a pressure of 400 pounds to the square inch and carried in tanks behind the cab. Should the pressure in the tanks drop below 360 pounds, a pump operated by electric storage batteries automatically replenishes them. Besides high speed, Boyette claims the advantage of exceptional economy in operation.

SHOTGUN SHELLS TEST PIPE FOR PLUMBING

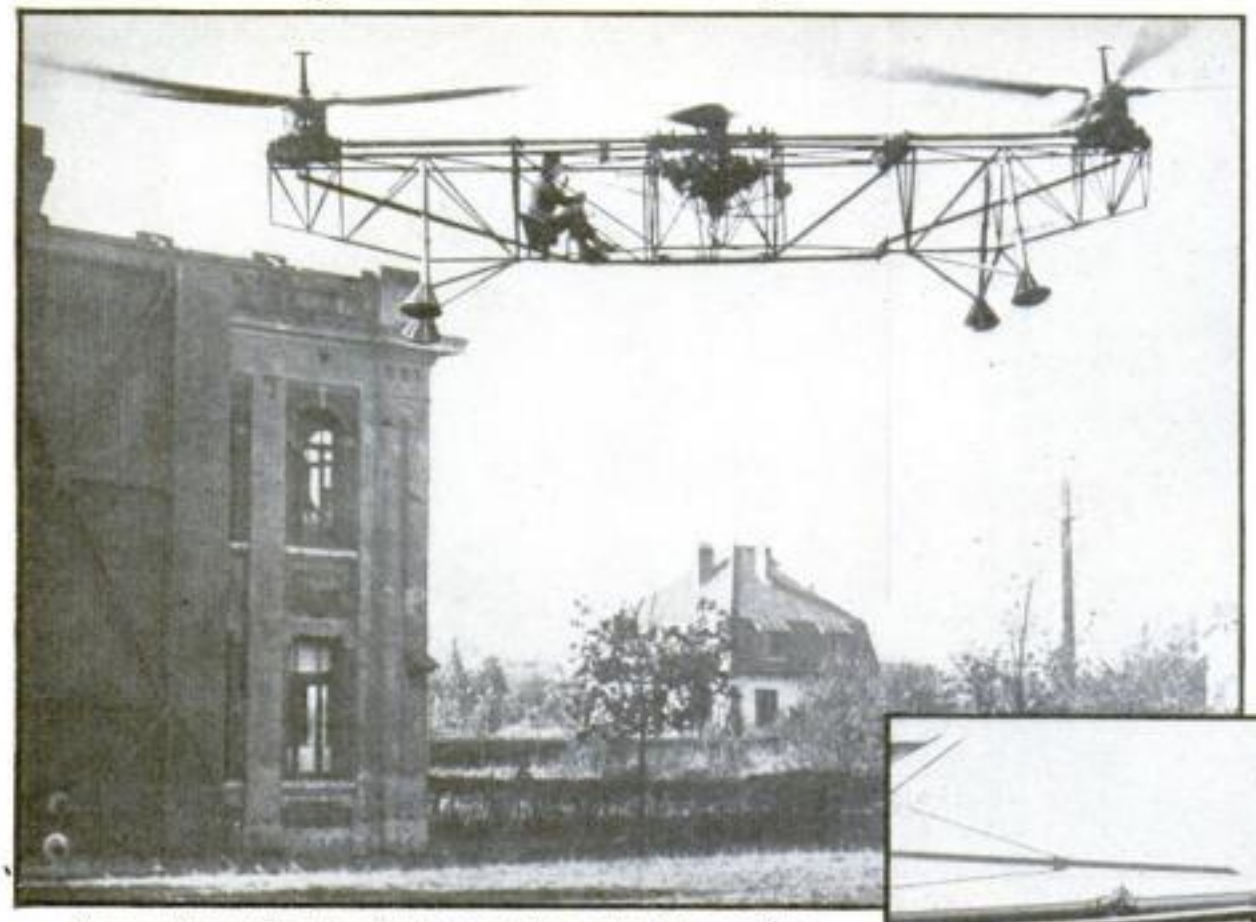
TO DEMONSTRATE the strength of modern plumbing materials, a manufacturer recently made a short section of copper water tubing into a miniature cannon and fired shotgun shells from it. The breech of the cannon, shown above, was a standard brass pipe adapter closed by a pipe plug, which was drilled to receive a steel firing-pin. Discreetly withdrawing to the end of the fifty-foot firing lanyard, the experimenters found that as much as three drams of powder—the standard shotgun load—could be exploded in the improvised barrel without bursting it. This explosion of course, exerted on the material an expansive pressure several times greater than any force of water would ever exert on the installed pipe.

ELECTRIC CURRENT IN SOIL KILLS OFF THE BACTERIA

HOME gardeners and greenhouse men may now rid soil of disease and pests by sterilizing it with electricity, through the use of apparatus recently developed by a Seattle, Wash., research engineer. Though it resembles electric heating devices previously applied to gardening, the apparatus is not designed to heat the soil by contact but by passing electric current directly through it, between electrodes that are buried in the earth. The mild heating is said to kill all parasites.

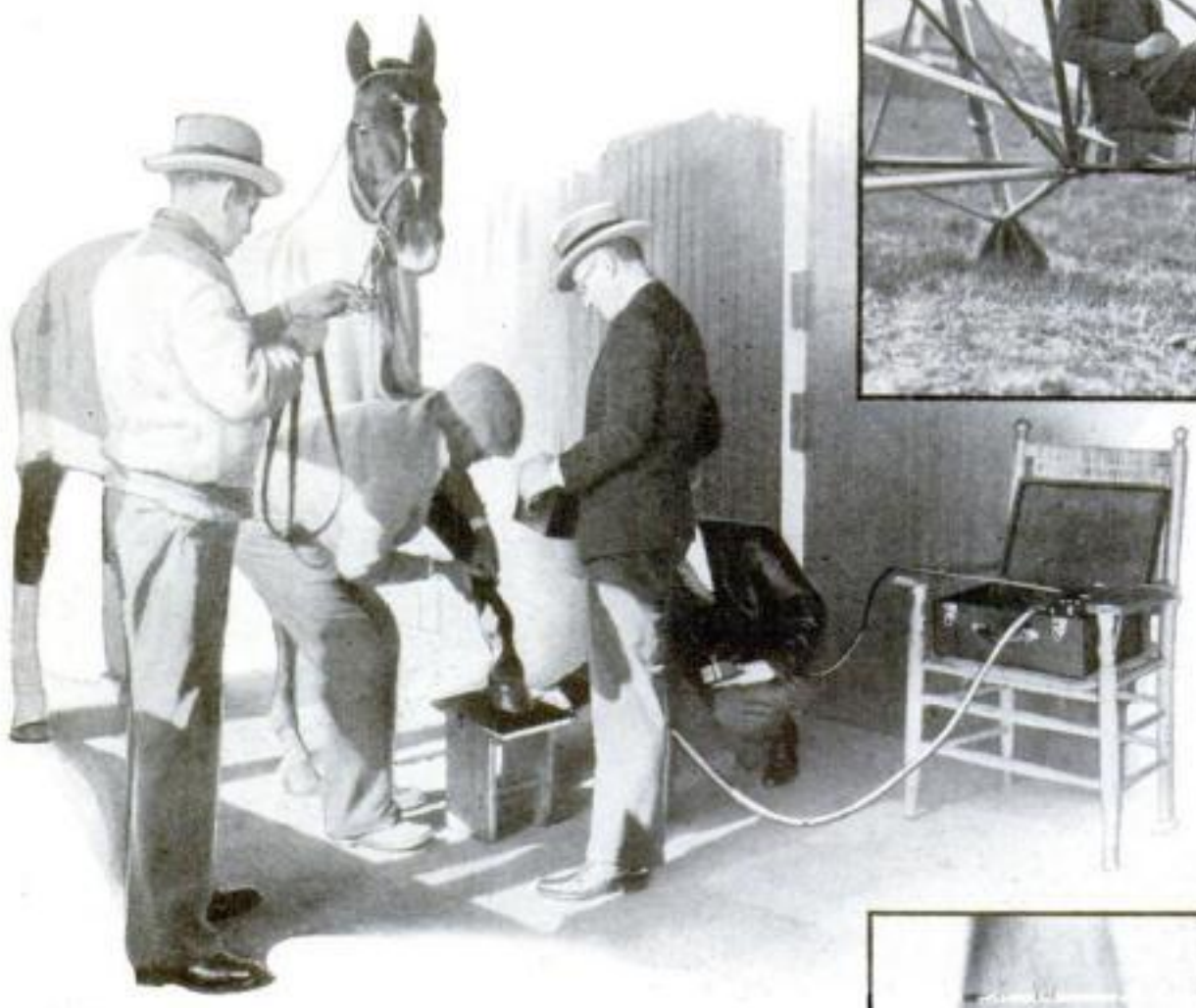
At top, electric soil sterilizer in use. Above, close-up of insulating material and plates

Belgian Helicopter Sets World Record



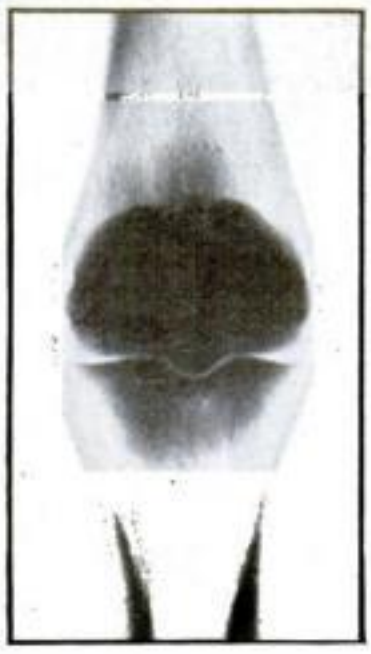
By remaining aloft in a helicopter of his own design for nine minutes and fifty-eight seconds, a Belgian aviator named Florine has just set a new world's record for these wingless craft, which are distinguished from other planes by their ability to rise and descend in a vertical line. The feat, performed at Antwerp, Belgium, is hailed as bringing nearer the day when helicopters will be a practical form of locomotion in crowded city regions where no standard plane could land and take off. Since it does not need to taxi along the ground, the Florine helicopter has no wheels, but lands on four shock-absorbing bumpers. Two twenty-four-foot propellers and one stub propeller between them, whirled by a motor of 200 horsepower, support the craft in the air.

Above, photo of Belgian helicopter taken while the machine was making a record flight. It remained aloft for nearly ten minutes. Right, its inventor talking to pilot before the take off



PORTABLE X-RAY OUTFIT MAKES PHOTOS OF RACE HORSE'S LEG

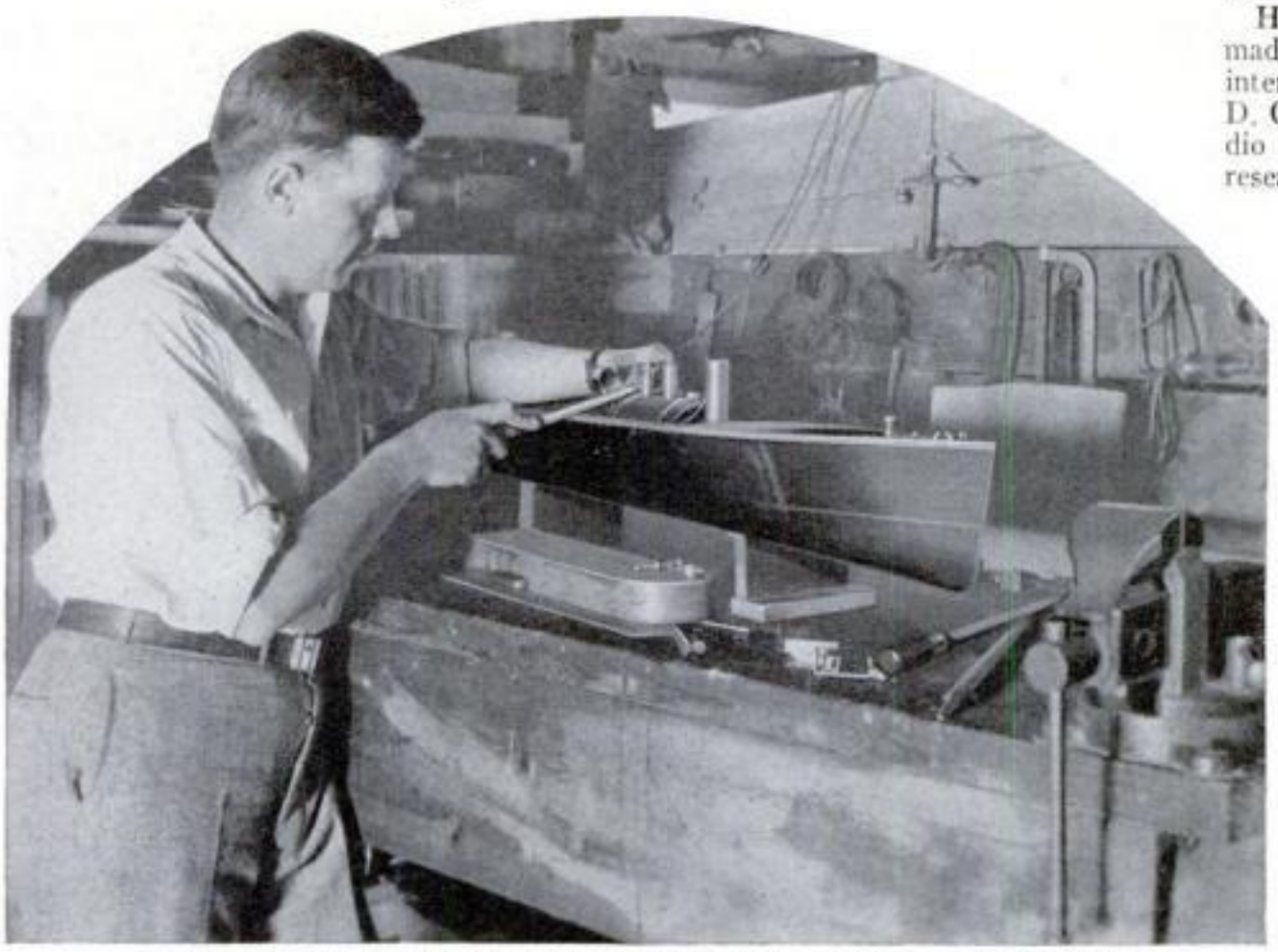
Making X-rays of a race horse's leg was the unusual task assigned the other day to a new portable X-ray outfit developed by General Electric engineers. The test was undertaken in an effort to find out why Equipoise, famous racer, became lame last summer during the height of his career, forcing his retirement from the track. Study of the dozen or more pictures taken, one of which is shown at right, may reveal the trouble and indicate whether the horse can be cured so that he can race again. The examination was a successful test of the X-ray outfit, which is portable, easily operated, and quiet.



QUICK-AGING PROCESS MAKES NEW WHISKEY OLD

American distillers, once more in the business of making whiskey after fourteen years of idleness, have taken a pointer from the bootlegger to speed up the process. Fearful of popular prejudice, few will admit that their product is aged by anything but time; in fact, however, many distilleries have been granted permission by the U. S. Bureau of Industrial Alcohol to try out scientific quick-aging methods that are said to accomplish in days the mellowing effect of years. Whiskey is aged in charred barrels, the charred wood absorbing esters, fusel oils, and other undesirable substances. Long before prohibition, distillers found that the process was accelerated by keeping the barrels in a well-heated warehouse, and still more effective means were discovered during the prohibition era. Distillers are carefully guarding, as trade secrets, their methods of adapting and improving on these. It is known, however, that running steam through a coil in the barrel is now the method most used, while experiments are being made with electric-heating apparatus, ultraviolet rays, and even Xrays. Distilling experts maintain that the new methods of quick aging yield a product fully as good as whiskey aged by time.

Model Speedboat Hits Thirty-Mile Clip

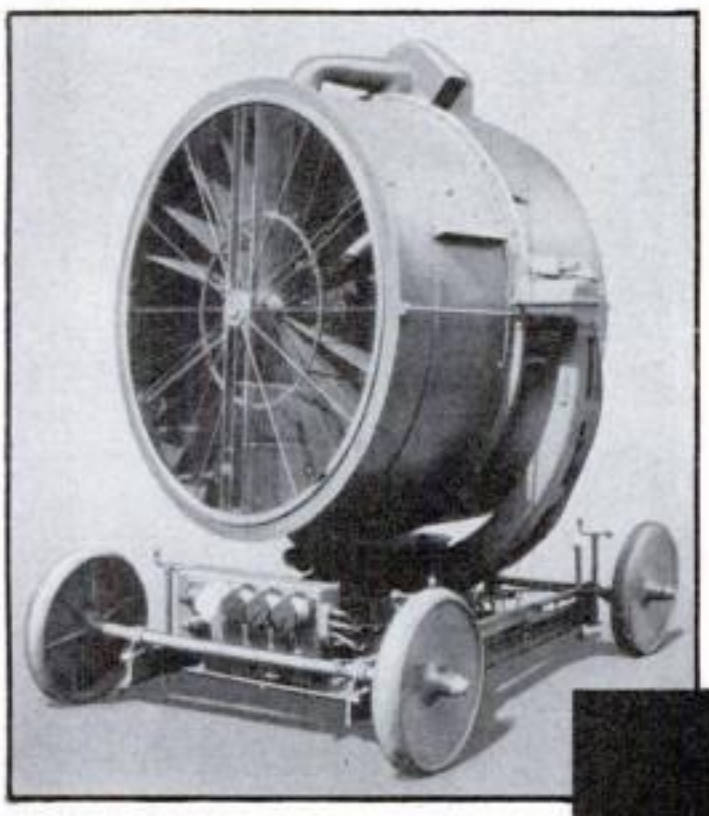


Elmer Luke, Washington, D. C., at work in his home workshop upon a model speedboat. Powered with a steam engine, this model has hit a speed of thirty miles an hour

How fast can a model speedboat be made to go? That is the question that interests Elmer Luke, of Washington, D. C., who during working hours is a radio expert at the Bellevue, D. C., naval research station. His leisure hours are devoted to his hobby of building miniature power boats, which not only run, but run at astonishing speed. One of his models rushes through the water at thirty miles an hour, under sixty pounds of steam pressure.

This particular model is three and a half feet long and weighs seven and a half pounds with its brass and copper engine installed. The handmade boiler of copper tubing is fired by a small gasoline blowtorch, and is provided with gages and a safety valve built to accurate scale. Steam from the boiler runs an efficient little engine of twin-cylinder, high-speed type, having a five-eighths-inch stroke, which drives the two-and-a-half-inch propeller. To protect the model boat from damage if it should hit an obstruction, Luke has provided a bumper in the form of an aluminum plate embedded in the bow.

Army Gets World's Strongest Searchlights



Provided with a lens sixty inches in diameter, the monster searchlight, left, is one of 104 ordered for the U. S. Army. It is the most powerful ever built

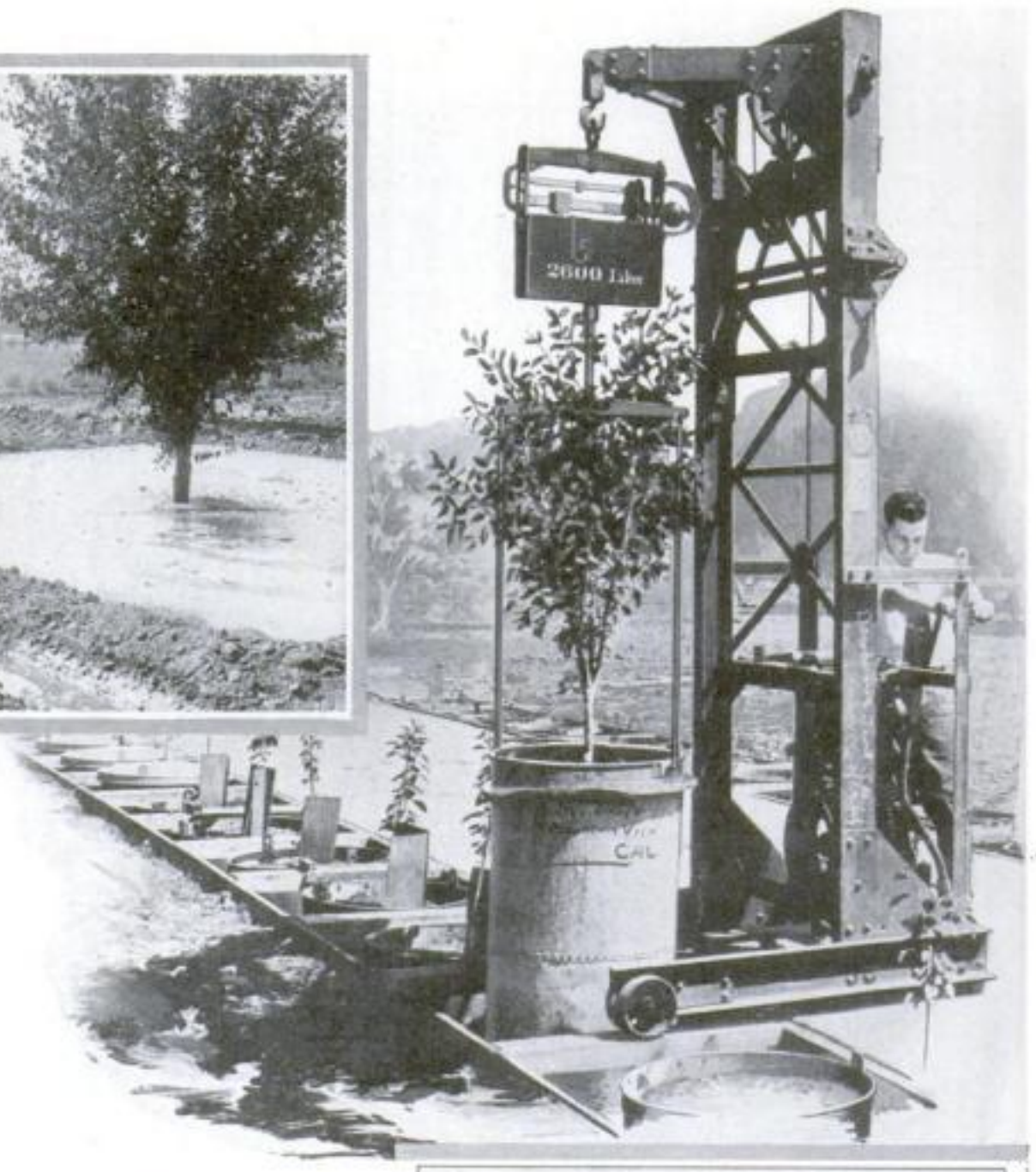
The huge searchlight is loaded on a truck, as above, to rush it to any desired point to repel an air attack. At left, the 800,000,000-candle power beam of light is being tested

To SUPPLEMENT its hitherto inadequate supply of anti-aircraft beacons, the United States Army has just ordered 104 of the largest and most powerful searchlights in the world. Equipped with a lens sixty inches in diameter, each one of these monster lights throws a beam of 800,000,000 candle power. So intense is this shaft of light that a hostile airplane could be picked up and spotted for anti-aircraft batteries while flying at a height of three miles. Sixty-one of the new searchlights will be mounted on trailers, to be towed behind trucks, while each of the remaining forty-three will be mounted upon a mobile chassis to facilitate loading upon a truck. The current for the lights is drawn from generators upon the trucks. Remote control enables the operator to direct the light's beam from a point several hundred feet away so it will not blind his vision. An innovation that contributes greatly to the mobility of the new lights is the use of a lightweight aluminum alloy in their construction. The beacons were designed by engineers of the Sperry Gyroscope Company and U. S. Army engineers.

STARTLING REVELATIONS ABOUT

Save Millions on

In this experimental prune orchard, a careful check is kept of the amount of water used in irrigating the trees. In this way the best amount is determined



Trees were planted in these cylindrical tanks so that at definite periods the trees could be lifted and weighed. Thus, the amount of water needed by a tree is found

By
Harold J. FitzGerald

FOUR and a half million dollars were saved California farmers last year because two scientists have learned how water soaks into the ground!

Ever since the close of the World War, Dr. Frank J. Veihmeyer and Dr. Arthur H. Hendrickson, of the University of California, have been following the mysterious trail of water after it disappears beneath the surface of the soil. Their findings have upset old ideas and promise to save billions of dollars for men who till the 26,000,000 acres of irrigated land in the United States. One out of every three states in the Union now produces crops made possible by irrigation.

Added timeliness is given to the report of the successful application of their discoveries by the fact that one of the greatest irrigation projects of all history is now under way in the Southwest. Two million acres of farming land will be added to the tilled area of this country when the great Boulder Dam of the Colorado turns its water into the desert regions of Arizona, California, and Nevada, a few years hence.

Since earliest times, three things have been assumed about water and the soil: (1) That plants and trees used moisture as fast as they could get it and flourished accordingly. (2) That water diffused itself through the sub-soil as through a lump of sugar. (3) That uncultivated land, exposed to the sun, would dry out.

By whirling, perforated pans, scientific see-saws, waxed-paper partitions and cross-section trenches, Veihmeyer and Hendrickson proved all three of these ideas were wrong!

As a first step toward learning how water actually behaved underground, they cut irrigation furrows through a plot of dry ground at the university's experimental farm at Davis, Calif., and ran measured amounts of water through them. Then they dug a six-foot trench across the line of the furrows, climbed into it, and examined its side for results.

Under one furrow in which they had run three inches of water, they watched the dampness descend through the soil to the depth of a foot, and then, suddenly, stop. Al-

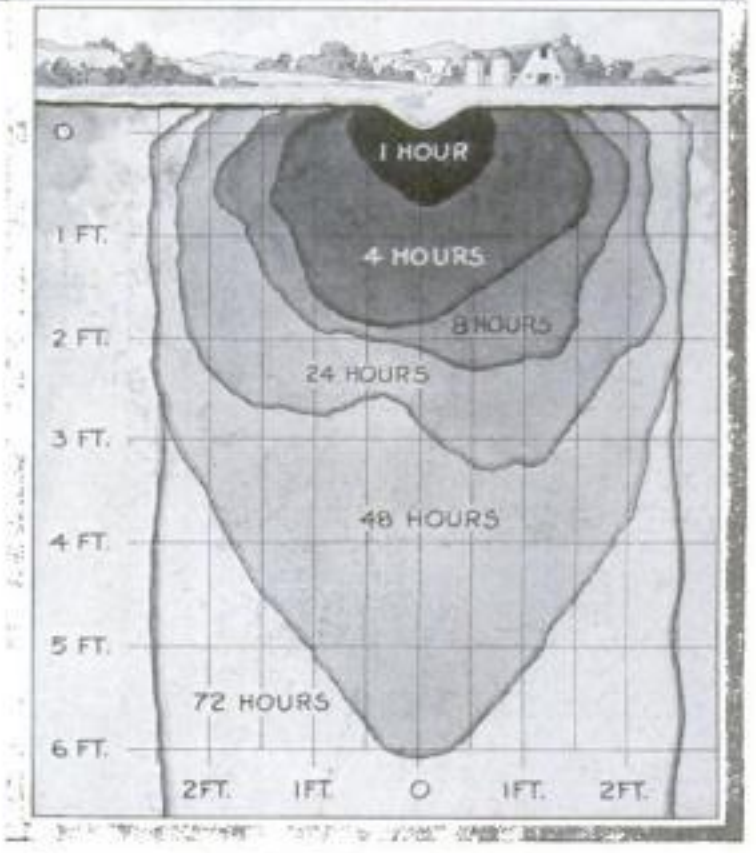


Diagram showing the efficiency of irrigation in an experimental plot. Note that the soil was moistened to a depth of two feet by both an eight-hour and a four-hour continued use of water. There is a clear-cut line between the soil that is wet and the soil that is dry regardless of the length of time the water was permitted to flow over the land

WATER, ANNOUNCED BY TWO SCIENTISTS,

Irrigated Land

Three-year old prune tree in tank weighing 1,200 pounds. In one season alone it lost 1,250 pounds of water

though they waited for hours, not a drop of water went below that one-foot level.

There was no shading off. Where the dry part began, it began abruptly, immediately adjacent to a thoroughly wet portion. They confirmed this scientifically, by taking samples of soil and testing them for their moisture content. They found that every portion of the wet area was equally wet, the water content in each being approximately twenty-five percent of the oven-dry weight of the soil.

Again they ran three inches of water in the furrow, and now they watched a curious thing happen. The top foot, through which this had to percolate, was not a whit wetter, after the percolating had finished, than it had been before. But the second foot became exactly as wet as the first, and just as uniformly so. Then abruptly where the third foot began, the soil was as dry as though never watered.

By carefully measured irrigations, they were able to wet each foot or half foot to exactly this twenty-five percent ratio of wetness, clear to the bottom of the trench. But no amount of water would make any portion any wetter than this; and no layer, no matter how far down, could be found to contain any lower percentage of moisture.

Why was it, they wanted to know, that there couldn't be different degrees of moisture in the same soil?

In the laboratory, a rapidly revolving pan, with perforated sides, which threw the moisture out of the soil by centrifugal force, finally led them to the answer.

There is a fixed amount of moisture, they discovered, that any given type of soil particles will hold so firmly as to resist the pull of gravitation. Until a layer of particles has received this full quota of water, it will let no moisture pass through it, but will seize and hold it avidly. When the capacity of all those particles is reached, additional water flows down to the next layer, and then to the next, bringing each to its full holding capacity before proceeding further.

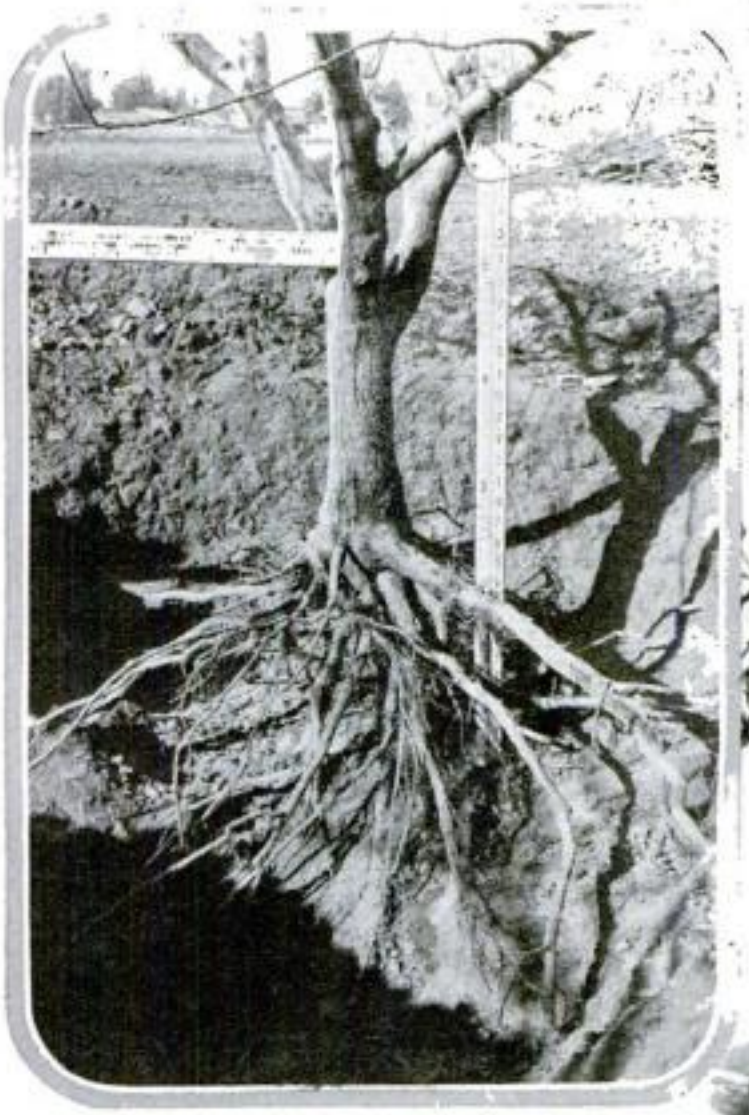
So as far down as the water goes the soil must be wet to a uniform degree, represented by that soil's holding capacity—or field capacity, as the investigators term it. No soil, consequently, can be half wet, or three-quarters wet. No soil that is subject to drainage can be saturated, except for the brief period necessary for the downward movement of water, for every ounce above field capacity is dragged to a lower level by gravity. When the movement is free, therefore, the water goes down like a window shade—of uniform thickness all the way until, suddenly, there is no more.

Microscopic examination revealed that the water is not held inside the particles, but between them, being supported in tiny wedges at the points where the particles come together. This discovery led Professors Veihmeyer and Hendrickson to test various kinds of soils for their water-holding capacities, and they found, as they had expected, that these varied in accordance with the size and number of the soil particles and the firmness with which they were pressed together.

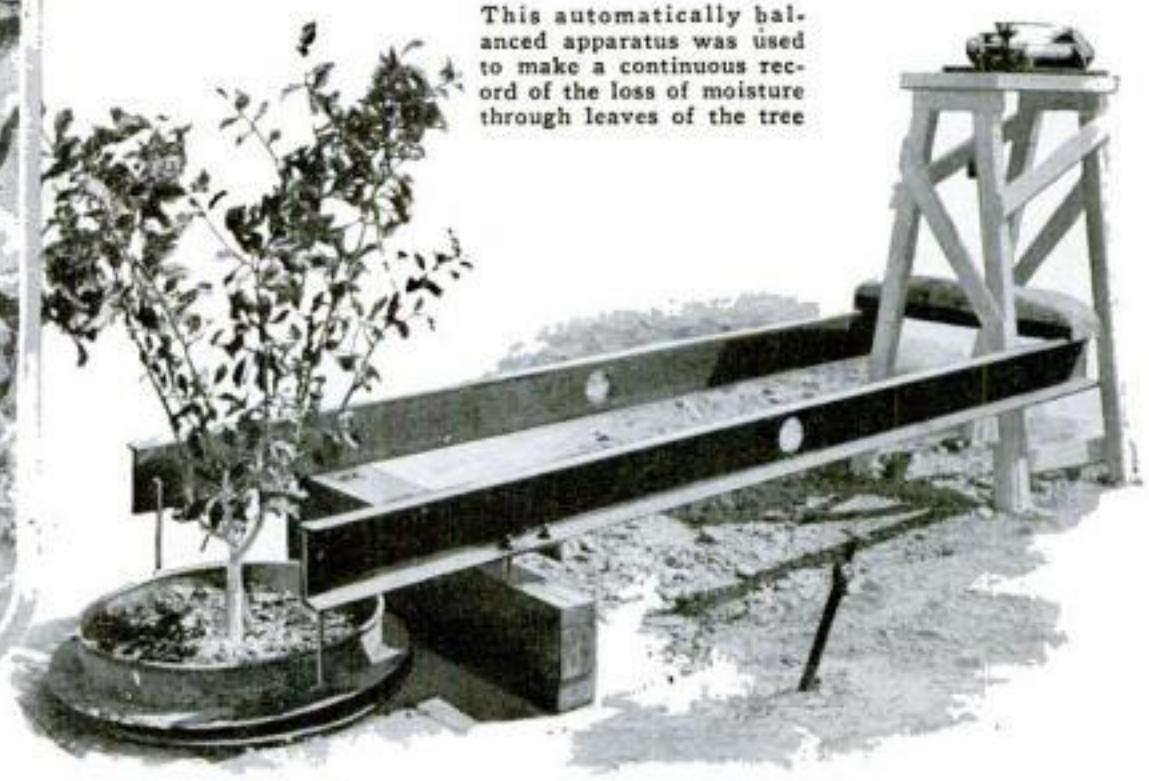
Clays and loams hold more water than sands, as there are more separate particles and they are wedged more tightly together, thus offering greater obstruction to the water's passage. But however the field capacity may vary for different soils, for any given type of soil it is always constant.

Farmers and scientists alike have always taken it for granted that trees used up the available water in the soil as fast as the roots would permit, with the sun and its attendant evaporation processes making it a close race as to which would get the water first. To determine exactly what respective roles trees, sun, and perhaps other forces were playing in this scramble for water, the two scientists rigged up an ingenious experiment.

They planted trees in large cylindrical tanks which *(Continued on page 103)*



In this picture, the earth has been removed from around the roots of a mature apricot tree to show the measurements of the underground root spread

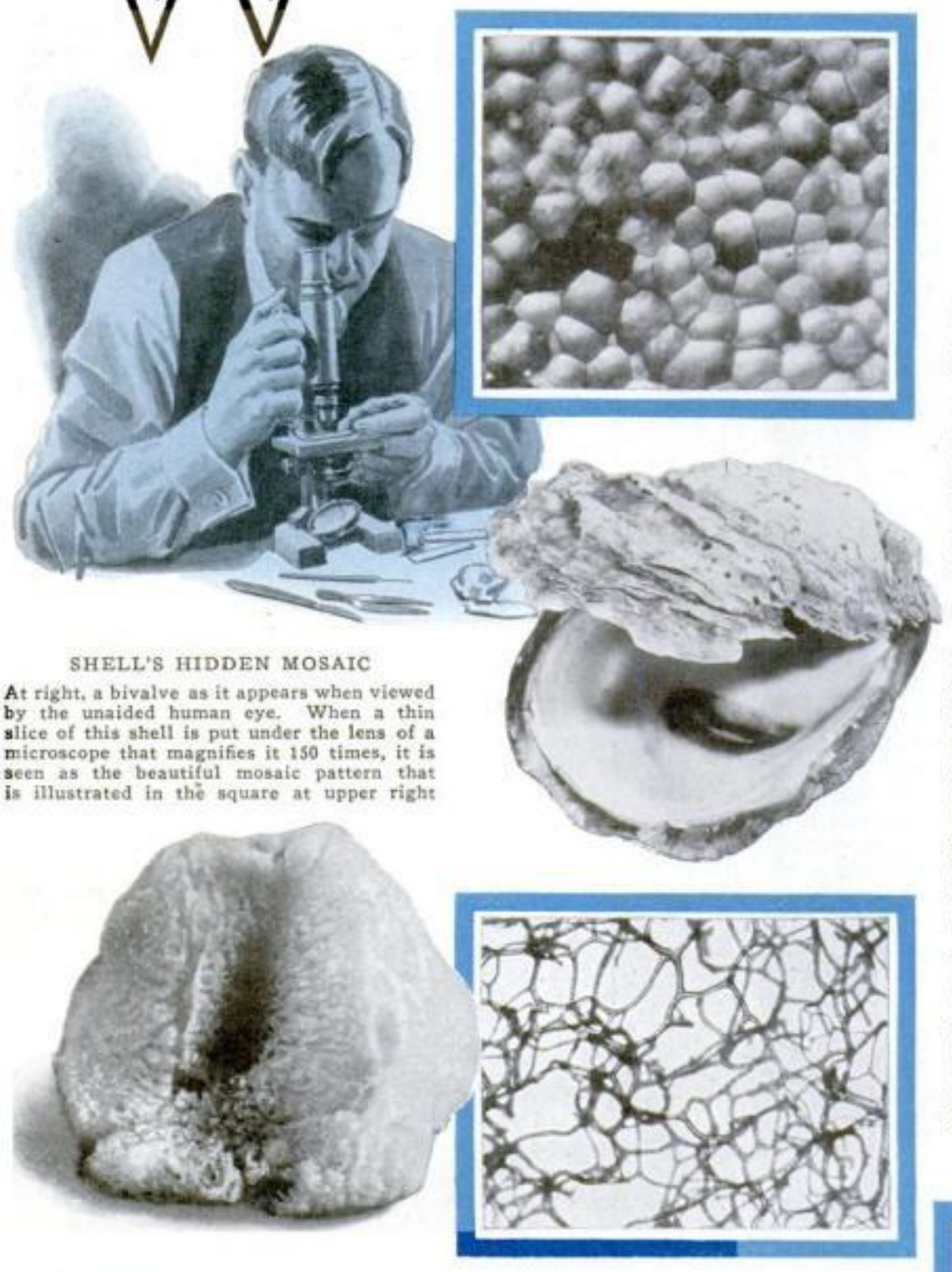


This automatically balanced apparatus was used to make a continuous record of the loss of moisture through leaves of the tree

Wonders of the SEA

How Marine Specimens, Easily Examination — Making Your

BY MORTON



SHELL'S HIDDEN MOSAIC

At right, a bivalve as it appears when viewed by the unaided human eye. When a thin slice of this shell is put under the lens of a microscope that magnifies it 150 times, it is seen as the beautiful mosaic pattern that is illustrated in the square at upper right

FINDING A SPONGE'S SECRETS. At left, above, an ordinary bath sponge. At right, a slice of it, viewed under a microscope that magnifies it thirty-five times

NO MATTER where you live, many of the wonders of the sea can be brought beneath the lens of your microscope. A visit to the seashore is unnecessary. You need only make a selection of things you will find either in your own home or at the neighborhood drug store.

For instance, the drug store, certainly, will be able to supply you with cuttlefish bone, originally intended for the pet canary. There also you can get cheap little yellow sponges and shells fashioned into novelties. Almost every home has bits of coral brought from Bermuda or Florida. These articles are enough with which to start your fascinating exploration of the marvels of the great seas.

Take first the cuttlefish bone. Examine it carefully and you will find that it is made up of a thin, hard shell shaped like the bowl of a spoon. The hollow side is filled with a soft, chalklike material that canary birds like to pick. This material is lime that was deposited by the cuttlefish.

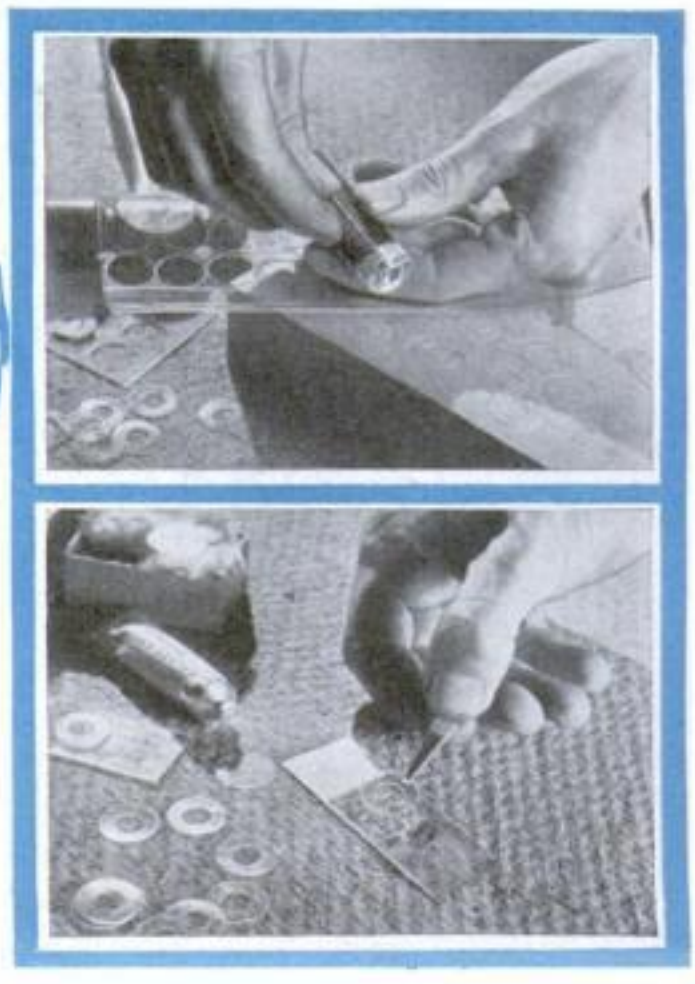
If you are acquainted with the cuttlefish, you will know that this bone really is a shell found directly beneath the skin of the animal's back.

With a sharp knife cut a piece from the soft portion of the shell, and carefully trim it to form a cube. With your unaided eye you can see that, on one face, the material is made up of nearly parallel lines or plates resembling somewhat the end grain of wood. Trim this face of the cube so that it runs squarely across these lines. Then trim an adjacent face parallel to one of the plates. Lay the piece on a glass slide, with the lined surface uppermost; and arrange the illuminator so that a beam of light is directed on the top surface, striking it at a fairly sharp angle. Look into your microscope.

Did you ever see a commonplace object become suddenly more beautiful?

The cuttlefish bone, at fifty diameters, is revealed as a crystalline palace containing a succession of fairy caverns. It looks, indeed, like a cross section of a many-storied glass building. You can see floor upon floor running across the field of vision in slightly curved lines. But instead of orderly rows of individual columns supporting the successive floors, you see an apparently confused arrangement of what appear to be thin partitions, broad pillars, and several iciclelike projections extending part way up or down.

After studying this surface of the cuttlebone cube you still may be in doubt as to the exact way in which the builder of this remarkable structure provided for the support of the successive floors. Turn the specimen over until the next surface, the one cut at right-angles to the first, is in view. If you have trimmed the piece properly, you can see



At upper right, a homemade punch is used to cut washers from celluloid. These help in making slide cells. At right, one of the washers is being placed on a slide that has been smeared with balsam. Above, nail ejects washers

Through Your Microscope

Obtainable, Are Prepared for

Own Bell Jar at Slight Cost

C. WALLING

how the supporting members are arranged.

It is as if you were directly above a building from which the roof and part of the top story had been removed. The layers of the cuttlefish bone, you find, are separated and supported by thin ribbons of lime, winding in and out among each other. If the builder of that bone had been working with steel instead of limestone, he would have supported the floors by means of thin sheet-metal plates bent in and out, like irregularly corrugated iron, to give them great strength.

But why all this complicated structure, instead of a simple deposit of limestone?

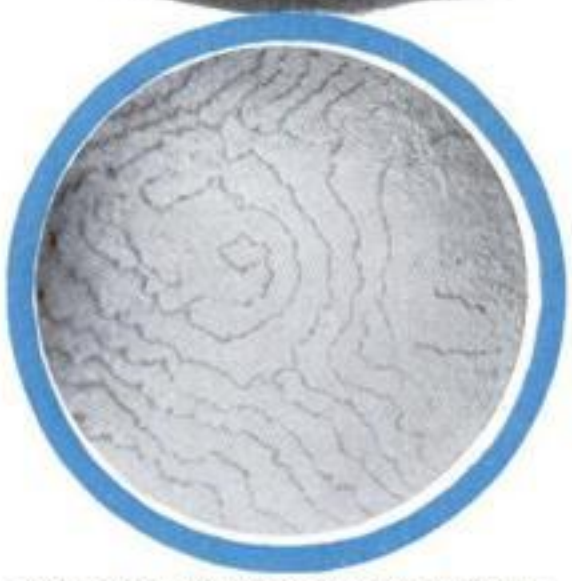
Reflect a moment, and you will realize that such material is, like corrugated metal or other material, light in weight and at the same time mechanically strong. Throw the bone into water and it will float, thanks to the thousands of tiny air cells in it.

Your microscope has proved to you that the cuttlefish bone, or, more accurately, shell, serves the double purpose of stiffening the animal's body and acting as a float. You will have to admit that, with such heavy material as lime, the builder of this float has succeeded remarkably well.

The little yellow sponge you purchased is not a whole sponge at all, but only the skeleton of a water animal known to zoologists as a member of the Phylum Porifera—meaning, in everyday language, a classification of animals that have characteristic pores or holes in their make-up.

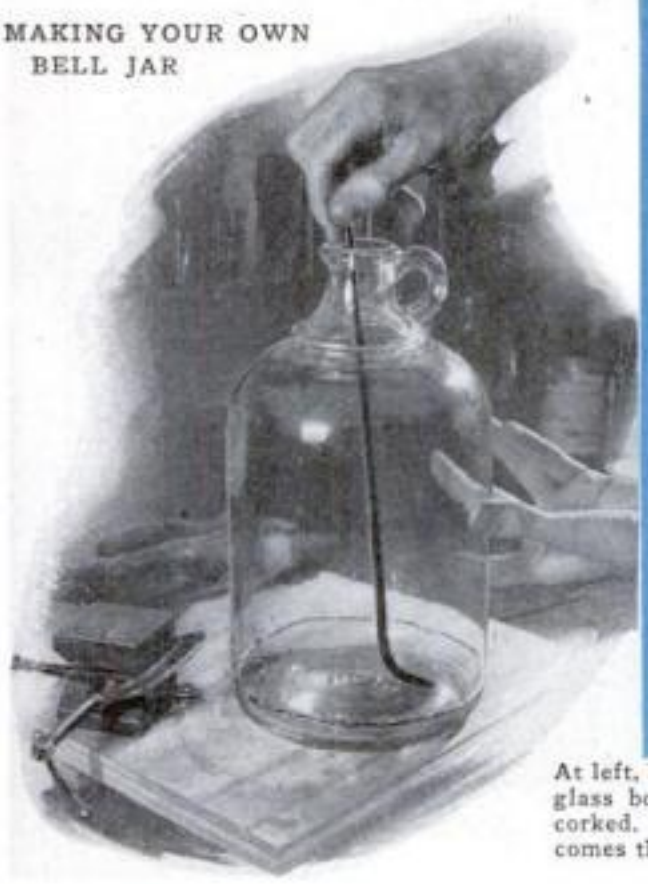
With a sharp knife or shears clip a small, thin slice from the sponge. You

CUTTLEFISH-BONE SPECIMEN. At left is illustrated the method of cutting a piece of cuttlefish-bone into a small cube for microscopic examination. Above, the specimen as it appears when magnified about fifty times



Microscopic view of mother-of-pearl from a sea shell, showing the tiny ridges that are believed to cause the iridescent appearance

MAKING YOUR OWN BELL JAR



At left, how the bottom can be cut from a one-gallon glass bottle, the mouth of which is then securely corked. With the cut edge bound with tape, it becomes the bell jar for a microscope, as is seen above

may be surprised at the toughness of the material. Lay the slice on a glass microscope slide and drop over it a clean cover glass to prevent it from being blown away. Use a low power at first, and focus on the fragment.

What you see is a three-dimensional network of horny fibers. There are few branches with free ends, except at the cut edges of the piece. The whole maze looks like something made by a miniature welder who amused himself by joining together rods of various lengths, without apparent rhyme or reason.

This horny maze, the skeleton of a sponge that once lived in the sea, is composed of a substance that is chemically related to silk. The scientific name of this material is spongin. It was secreted by special cells in the living sponge.

The network structure of the typical bath sponge is but one of the forms found among sponge skeletons. If you have, for example, a finger sponge, put a slice of it under your microscope. You will find it is made up of a horny network like the bath sponge, but that the structure is not nearly so clean-cut. There are numerous irregular projections or branches intermingled with the joined segments.

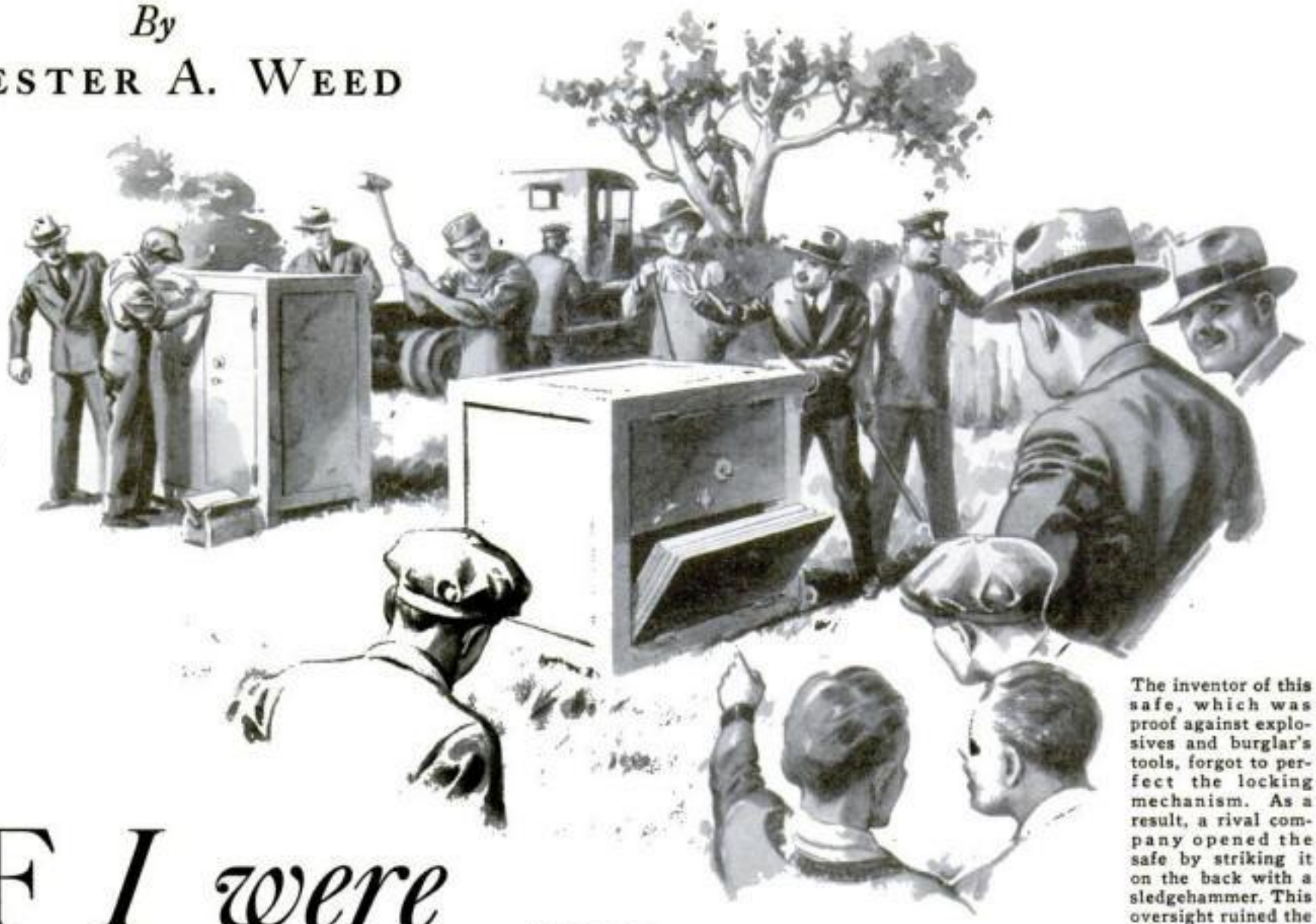
Other sponges—which you probably will not find in stores—have skeletons composed of needlelike bodies of silicon, or carbonate of lime. Under the microscope, they appear like simple needles or pins, like needles equipped with cross arms, or like pointed jacks with which you might play a game. These separate fragments adhere together with surprising tenacity.

Now that you have scraped an acquaintance with sponges by examining their skeletons, turn again to shells, this time to one of the bivalves with its mother-of-pearl lining. The shell of the pearl oyster, the mussel, and various shells picked up along the sea shore afford excellent material.

Select a piece of shell from near the edge, beyond the mother-of-pearl lining. Usually you can find portions that will transmit

(Continued on page 88)

By
CHESTER A. WEED



The inventor of this safe, which was proof against explosives and burglar's tools, forgot to perfect the locking mechanism. As a result, a rival company opened the safe by striking it on the back with a sledgehammer. This oversight ruined the safe's manufacturer

IF *I were Getting a* PATENT...

ONE night, a few years ago, an excited inventor rang my doorbell. He said he couldn't wait for office hours the next day. He wanted to get a patent right away and in every country in the world.

So far as I know, this has never been done. After a little calculation, I estimated the cost of taking out papers in every country that has patent protection at close to $10,000. Without batting an eye, he pulled out a checkbook and said he would write a check for the whole amount if I would start getting the patents first thing in the morning.

He had devised a detachable bow for party slippers which could be changed to match the color of the dress and he wanted to begin its manufacture as soon as possible. It was only after considerable discussion that I persuaded him to let me make a search of former patents to be sure the idea was new. And then, the first thing I found was the identical idea which had been patented just thirty years before.

For nearly half a century, I have been engaged in patent law. I have dealt with a host of inventors. I have seen some make fortunes and I have seen many make mistakes. Time and again, during these fifty years on the patent battlefield, I have watched the same mistakes, the Six Slips of the inexperienced inventor, appear and reappear. They are the ones I would especially try to avoid if I were getting a patent.

In the first place, I wouldn't be in too great a hurry.

The man with the interchangeable bow is but one of many with whom I have dealt who wanted to rush in without waiting for a careful search of existing patents. Such a search, costing from $5 to $15, saves both grief and money in the end and should be thorough.

While the inventor can make the search himself at the patent office, it pays to have an expert do it. There are thousands of sub-classifications under the different headings and an inexperienced person is likely to miss the all-important one. Usually, it is unnecessary to look up foreign patents. This would cost more than filing the application and, as a matter of routine, patent office examiners make such a check when they go over your papers. Anyhow, the chances are that if the idea has not been patented in America, it is novel.

In fact, everything under the sun seems to be included in the patent papers on file in Washington. I remember, on the same day, finding a patent on a method for tying a cow's tail in a knot to keep it from switching milkers in the face, and a meter to be attached to a hen's tail-feathers to make an automatic count of the number of eggs it laid!

If common error number one is being in too much of a hurry, error number two is being too slow. In at least one

Inaccurate drawings frequently ruin patents. So be sure all drawings and sketches are exactly right

phase of inventing, you can't be in too much of a rush. That is in having all your sketches and notes witnessed and dated. Yet, my experience has been that few inventors ever date anything. I once had one bring me his papers all signed and witnessed but without a single date on any of them. In an interference suit, where it is necessary to prove the date of conception of the invention, undated notes are worthless scraps of paper.

As you know, the search covers only the patents that have been issued. It does not cover the applications, sometimes numbering 100,000, which are piled up in the patent office. Only the examiners know what inventions the applications cover. Consequently, it sometimes happens that two applications are filed by different inventors for the same invention. Then the officials declare an interference and decide from the evidence which man thought of the idea first.

In such a suit, every shred of evidence showing when you first thought of your invention is of vital importance. So, if I were getting a patent, I would date and have witnessed every note and sketch of importance as soon as possible.

Under rather dramatic circumstances, a few years ago, a valuable patent was saved for an inventor because he followed this rule. In an interference suit, his opponent produced papers dated six months earlier than the sketches the inventor had in his safe. His claim to the invention seemed gone until he discovered, among rubbish papers in his workshop, the first drawings he had made when the germ of the idea occurred to him. As these lost papers had been dated and signed by a notary public fully a year before the date on the sketches in the safe, the inventor was awarded the patent on the basis of obvious priority.

Having a notary date and stamp your papers, is one method of protecting yourself. Some inventors have slipped their sketches and notes in a sealed envelope and sent them to themselves by registered mail, the postmark and registration date giving evidence that the invention was conceived before that time. However, in court, you must prove that the envelope was never opened, and this is sometimes an extremely difficult thing to do.

A better method is to show your papers to a friend you can trust, explain the invention to him, and have him sign the sketches for you, putting on the date. This also, has its drawback. In the interference trial, such witnesses must explain all the details of the invention as well as swear they signed the papers. Usually they are hazy about the details and, not being able to give a clear description, injure your case. Be sure, if you employ this method, that your friend thoroughly understands your idea.

The best method of all, I have found, is to have a professional draftsman make working drawings of your invention, sign and date the drawings, and return them to you. Such a draftsman is disinterested, is not a personal friend, and is the best possible witness in an interference suit. He can always recognize his own handiwork and can invariably give a clear description of the invention because he has to understand it before he can make the working drawings. The fact that you hire him to make the drawings and he signs them for you, protects you from having him apply for a patent on your invention. Such evidence would prove conclusively you were the real inventor.

Before You Apply for a Patent...

1. **Take time to have a thorough search made for previous conflicting patents.**
2. **Date, and have witnessed, as soon as possible all notes and drawings.**
3. **Go carefully over all drawings for changes or errors.**
4. **Check your claims to be sure you have included all essential details.**
5. **Reduce your idea to practice at the earliest possible moment.**
6. **Refuse to give up the first time an examiner says your invention is not new.**

It is in connection with drawings that we come to common error number three. If I were getting a patent, I would give special heed to getting all sketches and drawings right. For example:

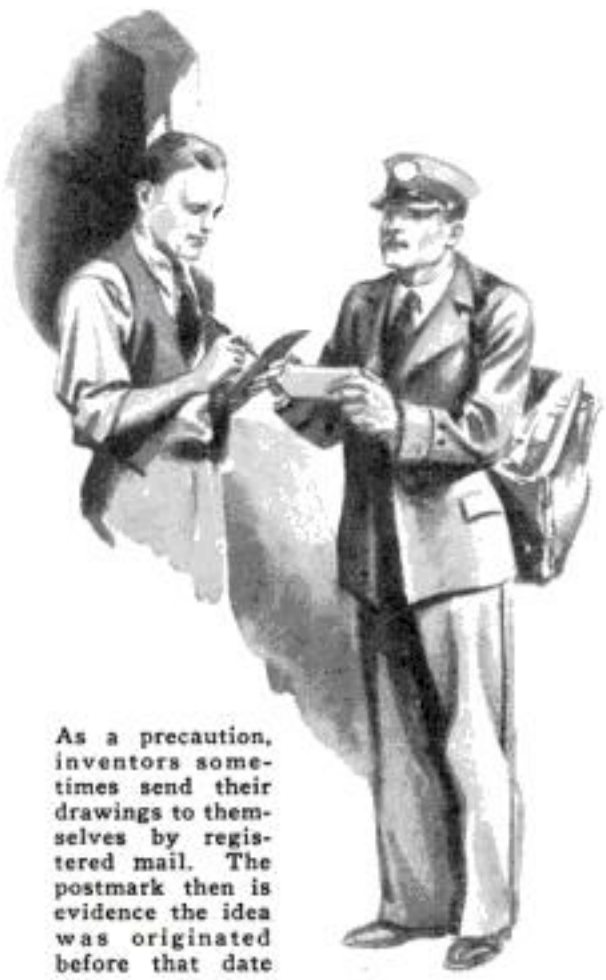
Four or five years ago, an inventor almost lost an otherwise clear case in an interference suit because the original drawings he had had witnessed contained pencil lines that had been erased and altered. Although these changes had been made before the witnesses signed the paper, the opposition contended the drawings had been altered subsequently. There is no way known to science of determining the exact age of a pencil mark. So it was only after a terrific battle that the inventor was able to convince the patent office officials that he should have the patent.

Consequently, if your sketches are erased and altered in any way, make clean copies before you take them to a notary or have them witnessed by friends. Also it is well to use indelible ink instead of ordinary writing fluid. There is less likelihood of changes having been made in drawings where indelible ink is employed and this adds that much weight to your case.

Another thing: While the patent office does not require that your drawings be accurate as to measurements, it does demand that they show an operative structure. Surprising as it may seem, I have seen scores of drawings showing moving parts that couldn't move. Screws sticking out of rotating shafts, for example, would prevent their turning. Minor slips made by the draftsman in preparing patent drawings can be corrected after the papers are filed in Washington. The patent office draftsmen can be employed to make such changes, the charge being from fifty cents up. In such cases, the original drawing is photostated and the copy placed on file and then the original drawing is corrected. But, if the mistake is one that leaves out something vital to the invention, it cannot be added as no new matter can be added after the case is filed. So a careful check-up on all drawings is a vital part of the work of getting your patent.

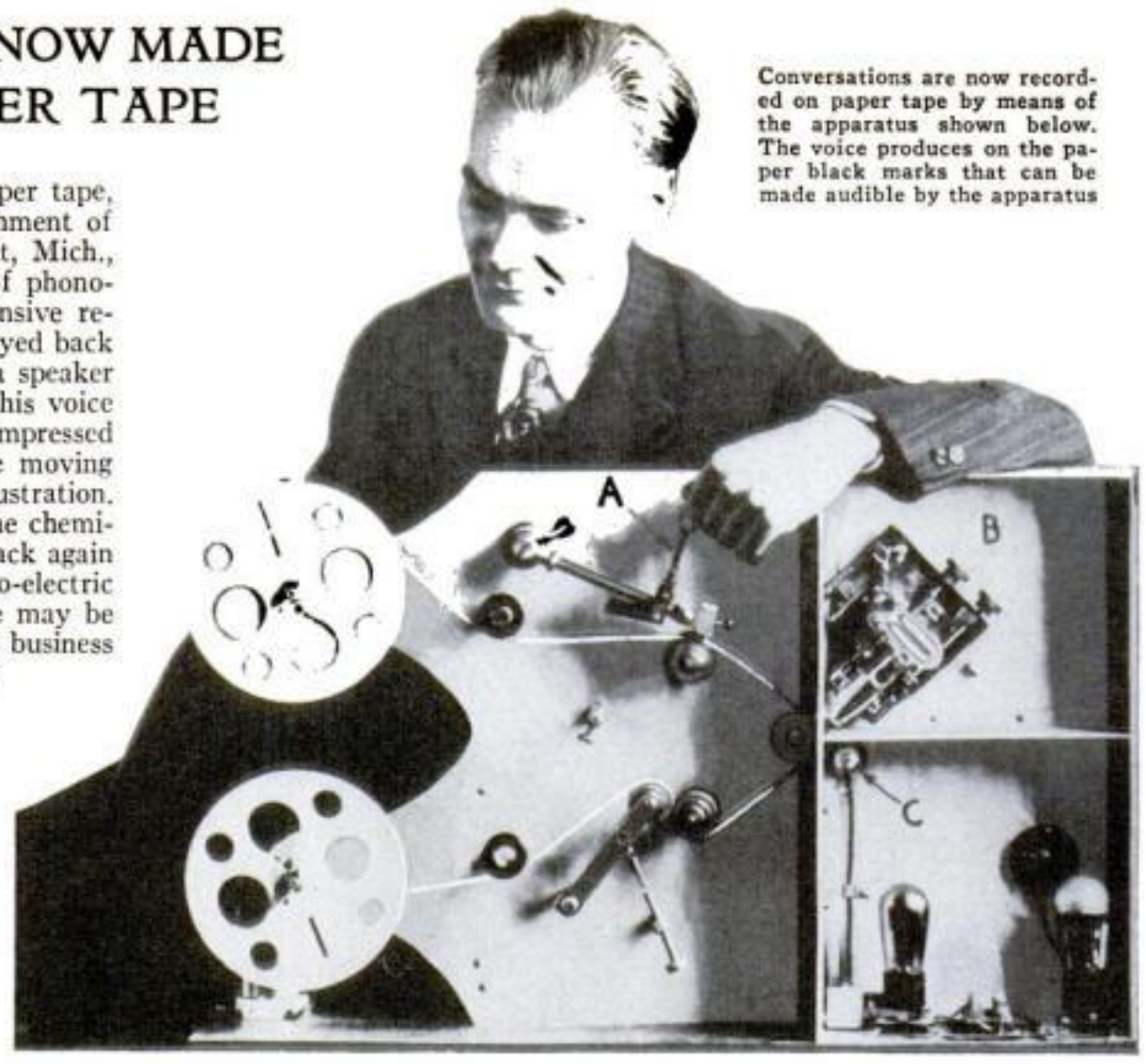
The most curious case I ever heard of in which an inventor slipped up on a vital part of his invention occurred a dozen or so years ago. By use of new metal and a radically new design, he had produced a burglar-proof safe. It couldn't be drilled into, or forced open and nitroglycerin couldn't be introduced in any crack. In competitive tests, it withstood every known trick of the cracksman. As a result, the safes were adopted by banks all over the country. Then, like a bolt of lightning there came an anticlimax to this story of success.

Another company challenged the inventor to an open exhibition. At the appointed time, the safes were placed in a huge open field and the experts on both sides set to work. The explosives man employed by the inventor prepared his putty well and got ready to blow the door off the competitor's safe. But while he was doing this, the crowd was watching with open-mouthed amazement the actions of the men employed by the competitor. They simply rolled the inventor's safe over on its side, hit the back three or four *(Continued on page 98)*



As a precaution, inventors sometimes send their drawings to themselves by registered mail. The postmark then is evidence the idea was originated before that date

RECORD OF VOICE NOW MADE ON MOVING PAPER TAPE



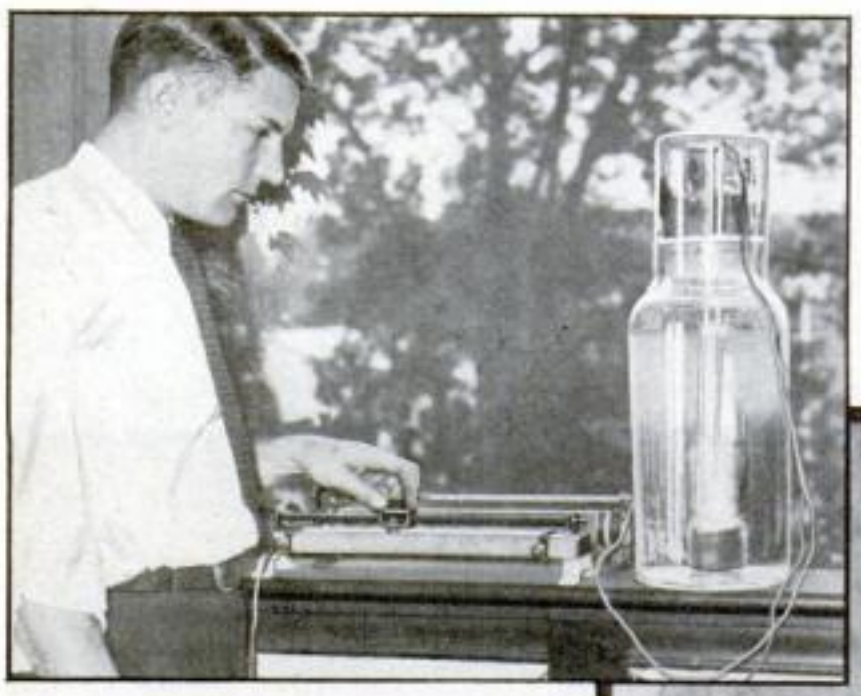
Conversations are now recorded on paper tape by means of the apparatus shown below. The voice produces on the paper black marks that can be made audible by the apparatus

RECORDING an hour's conversation on paper tape, at only a few cents' cost, is the accomplishment of a device invented by Merle Duston, Detroit, Mich., radio engineer. The tape takes the place of phonograph records or other comparatively expensive recording materials, and its record may be played back immediately or at any future time. When a speaker talks into the microphone of the recorder, his voice is translated into electrical impulses and impressed on a pair of electrodes between which the moving tape passes, at "A" in the accompanying illustration. This produces permanent black marks on the chemically treated tape, which are transformed back again into audible sound by a lamp at "B," a photo-electric cell at "C," and a loudspeaker. The device may be applied to such varied uses as recording business correspondence and courtroom proceedings.

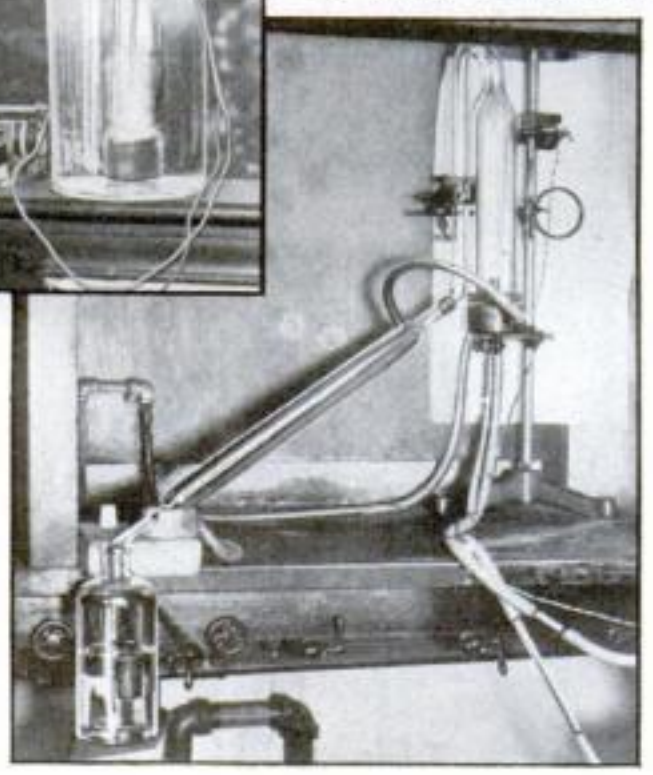
ELECTRIC EYE TO RAISE OR LOWER AWNINGS

FUTURE home owners will not need to bother to adjust their awnings, for these will be automatic, according to a recent prediction by J. J. Donovan, air conditioning expert of the General Electric Company. Photo-electric cells will lower or raise them automatically as the sun shines or goes under a cloud.

TESTS SEEK MYSTERY OF HEAVY WATER



With this apparatus, left, electricity is passed through ordinary water, part of which is thus decomposed into hydrogen and oxygen. The residue contains heavy water which has strange properties. When the gases, obtained by this electrical treatment, are recombined a light-weight form of water is obtained. The experiments are made at U. S. Bureau of Standards



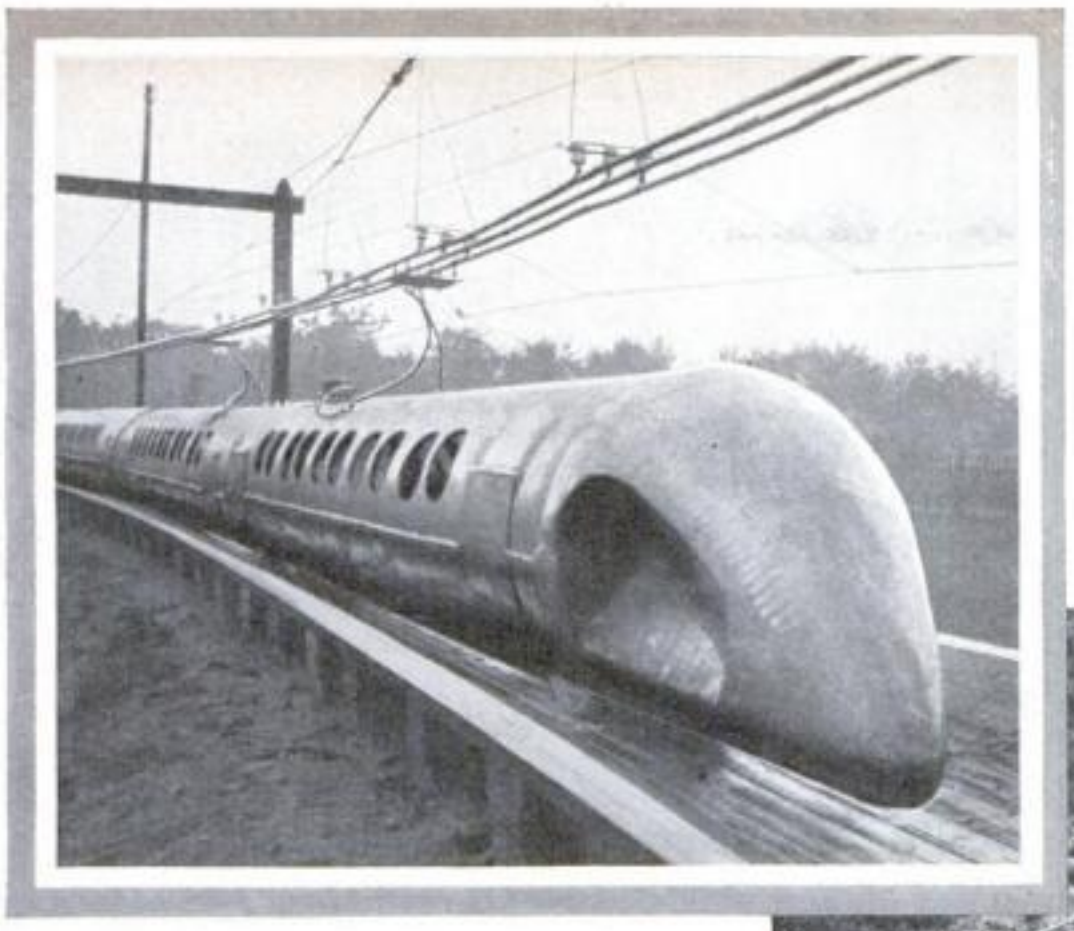
HEAVY water, one of the most mysterious of chemical substances, may soon become available in quantity to research workers who seek to ascertain its curious properties. Resembling ordinary water, from which it is made, it has been so rare until now that a teaspoonful of it has been valued at nearly $600. Its first production, a few months ago, followed the discovery that the hydrogen atoms in water are of two kinds, one comparatively light and the other heavy. Experimenters at the U. S. Bureau of Standards and elsewhere succeeded in preparing water containing an excess of the heavy kind by treating common water electrically. First tests to learn the properties of heavy water showed the surprising fact that seeds immersed in it failed to germinate (P.S.M., Nov., '33, p. 107). In more recent experiments conducted by Princeton University chemists and biologists, heavy water was found to kill tadpoles and other small fresh-water animals left in it for an hour. Now experimenters are wondering whether it may also be lethal to human beings.

JOINT QUICKLY SEALS WATER PIPE SECTIONS

PIPE sections are joined or detached at the flip of a lever, through the use of a new pipe joint introduced for temporary water lines. The sections are laid end to end, as in the upper view, and the short section of a doubly-hinged lever on one is caught over a hook on the other. Forcing the lever the rest of the way down, as in the lower picture, pulls the joint tight, a ring-shaped gasket insuring a leak-proof seal. Each section has a one-inch threaded outlet for a branch line.

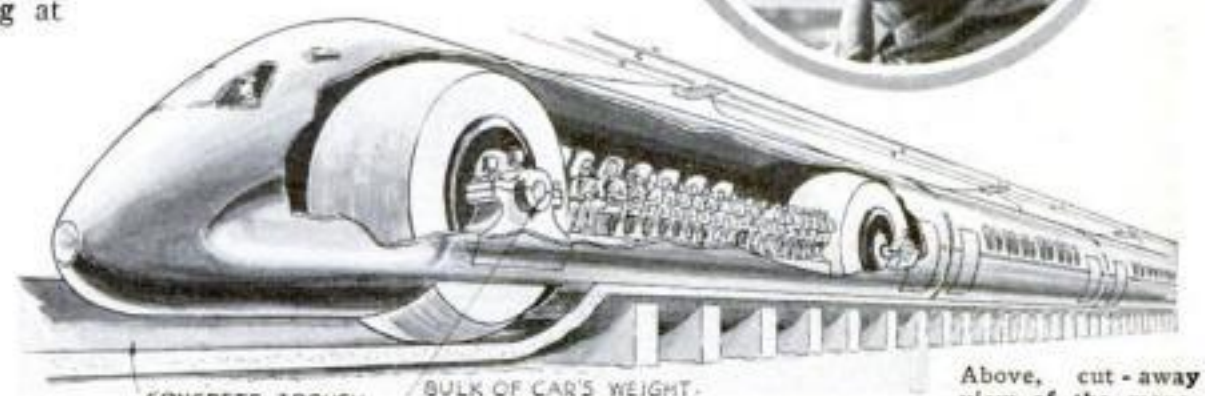
New Russian Monorail

RUNS IN TROUGH ON BIG SPHERES



Above, note the fishlike snout of the new Russian monorail that runs in a trough. At right, the strange train in action. In circle, M. I. Yarmanchuk, the inventor

FRAGMENTARY and conflicting reports from Russia of a revolutionary new type of railway under secret test there, which aroused the curiosity and interest of the American engineering world, have just been followed by the first complete details of the new system, and actual photographs of a working model in operation. Fully as remarkable as advance reports, the system proposed by M. I. Yarmanchuk, its inventor, calls for streamlined trains running at 125 miles an hour on giant, flattened spheres, twelve feet in diameter, instead of wheels. Each car is supported by two of these spheres, one at each end, and they are whirled by electric motors contained within their shells and mounted on the rigid axles. Since the center of gravity of the car lies below the axle, the car is not topheavy and will not easily overturn. A single curved trough of reinforced concrete serves as a track, entitling the strange system to be classed as a monorail. According to the inventor, this track should cost no more than a standard automobile highway to build. To test his scheme, the inventor has built and operated successfully near Moscow, a model railway with twenty-four-foot cars on a mile-long track. Plans are now under way to construct a thirty-mile railway on the same system, with 120-foot cars.



Above, cut-away view of the monorail to show how it runs on flattened spheres. At left, cross sections show principle of new system compared with the old types

FREIGHT-CARRYING RAILMOBILE TRAVELS ON RUBBER TIRES

CARRYING railroad freight on rubber tires looms as a commercial possibility, with the introduction of a new type of train for light hauling. The locomotive of this odd train is a six-wheeled bus that runs along the rails on rubber tires of special design, so constructed that they are not subject to the danger of going flat in case of a blowout. The cars are enclosed trailers.

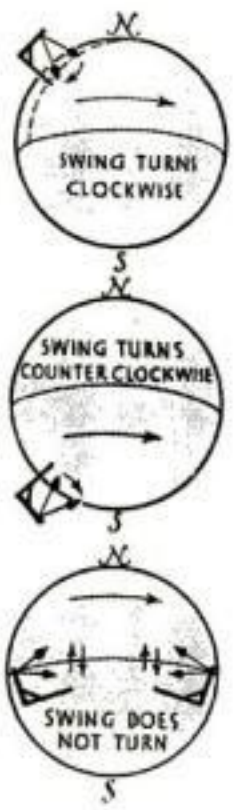
THESE EXPERIMENTS WITH

How the WORLD

Plumb Line Used to Make Visible

PENDULUM HELPS US SEE EARTH TURN

Above, direction of pendulum's swing is apparently changed by earth's rotation. At upper right diagrams showing that a Foucault pendulum seems to turn clockwise in the Northern hemisphere and counter-clockwise in Southern hemisphere. On the equator, no change can be observed in swing



FOR the man with a mechanical turn of mind there is a real thrill in seeing with his own eyes just how an ingenious machine works. It is more fun to *see* what makes the wheels go round than it is to listen to the cleverest description. That is why the famous pendulum experiment, which makes the earth's rotation actually visible, always arouses the keenest interest. Few people realize how easy the experiment is, or it would be done oftener.

The fact that a pendulum tends to keep on swinging in the vertical plane in which it is started, makes it possible to see the earth's rotation. You do not need to take this law of the pendulum for granted. You can test it for yourself.

Take a heavy plumb bob and suspend it by a yard-long cord from the middle of a one foot rule. Hold the ruler horizontally and set the pendulum swinging lengthwise of the rule. Then, without raising or lowering it, swing the rule a quarter way round its center in a horizontal plane.

The direction of the pendulum's swing will not be changed by this movement of the ruler, regardless of whether you turn the ruler quickly or slowly.

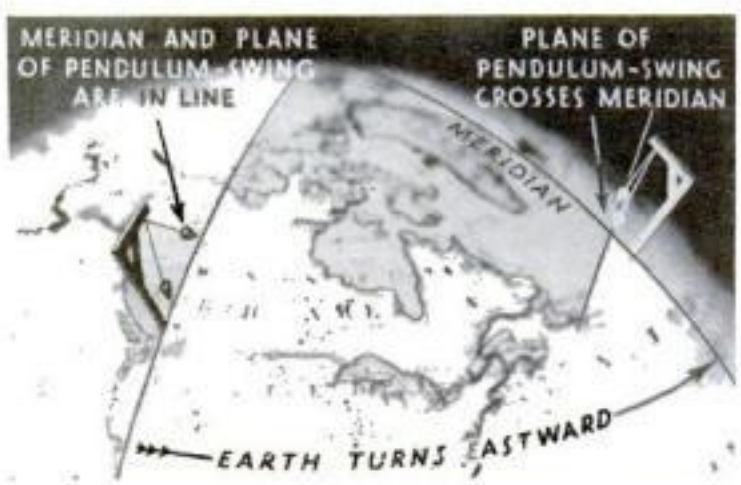
Now imagine the cord and plumb bob replaced by a wire 200 feet long, suspending a ball weighing seventy-five pounds. In place of the ruler, turned by hand, substitute the roof of the Pantheon in Paris, France, turned slowly round in space by the earth's rotation. This was how this celebrated experiment was first tried by the French scientist, J. B. L. Foucault.

He set his great pendulum in the Pantheon swinging in the plane of the earth's meridian, true north and south. But it did not long remain so. In a few minutes the line of the pendulum's swing was slightly northeast and southwest and it steadily became more and more so.

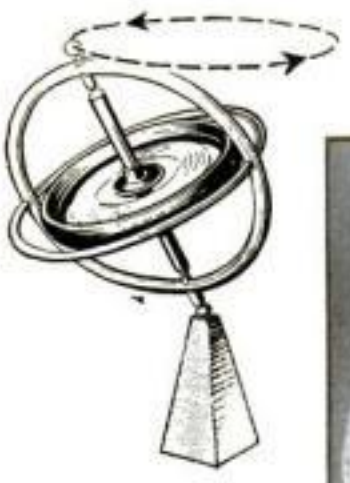
This seems at first like a contradiction of our ruler and plumb bob experiment, until we realize that the floor and roof of the Pantheon were turning, instead of the pendulum. The plane of the pendulum's swing was unchanged. The earth and the building, however, were slowly turning around it.

You can repeat Foucault's experiment with a long cord or wire and a weight of two or three pounds. The longer the cord, and the heavier the weight, the better your results will be because the pendulum will not come to rest so soon. But the rotation of the earth can be detected in fifteen or twenty minutes with a fifteen-foot cord and a two-pound plumb bob. The weight should of course be hung indoors to avoid air currents. A hook screwed into the rafter of a barn makes a good point of suspension. I performed the experiment in the spiral stair well of a two-story house, with a two-pound plumb bob and eighteen feet of fine wire to support the weight.

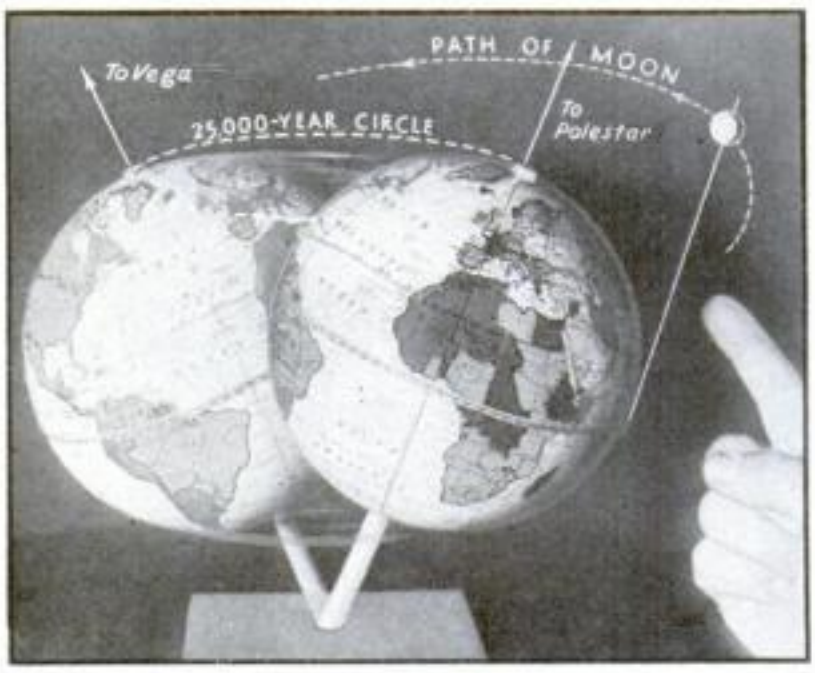
Just one word of precaution. Do not try to set the pendulum swinging with your hand. You may start it off on a long oval path, which will



This illustration shows why the direction of a pendulum's swing apparently is changed by the rotation of the earth, regardless of direction in which it starts



Above, a gyroscope top with the end of its axis precessing in a circle. Right, similar precessional circle of earth's axis. This is due to moon's pull upon earth's bulging line at the equator



EVERYDAY OBJECTS SHOW

MACHINE Works

Rotation of the Earth on Its Axis

ruin the experiment. Instead, tie the bob with a thread to a tack in the wall, and release it by burning the thread.

A little mountain ridge of sand or salt should be spread out across one extremity of the pendulum's swing, so that the point of the bob will cut through it at each beat. The gradual shift of the point in the clockwise direction knocks down the crest of the sand ridge, and enables a very slight variation to be detected.

We can perform simple experiments that show how the attraction of the sun produces ellipses, parabolas, and hyperbolas in the solar system, and also make clear to us the shapes of these curves.

The most important piece of apparatus in our first experiment is an electromagnet to play the part of the sun which attracts both planets and comets. You can make a magnet by wrapping forty or fifty turns of insulated wire around a large carriage bolt. Split apart enough double wire to wind the bolt and use it single, connecting a lamp into the circuit.

Then carefully smoke a pane of window glass over a candle flame, and hang the bolt so that it just touches the smoked surface. First, however, level the table accurately with a spirit level.

Lastly, take a steel ball bearing, and make a paper tube into which the ball fits loosely.

Start by blowing the steel ball out of the tube across the surface of the smoked glass plate. Direct the tube so that the ball rolls close to the magnet.

With a little practice you can produce an ellipse, a parabola, or a hyperbola almost at will, as the form of the curve depends upon the velocity with which you drive the steel ball past the magnet.

A little force allows the ball to be held captive by the magnet and swung clear round it in an ellipse—a closed curve.

Periodic comets, like Halley's comet, travel in the long closed curves, while some other comets enter the solar system at high speed, shoot past the sun and disappear forever in an open endless curve.

HOW THE PLANETS GOT THEIR ORBITS

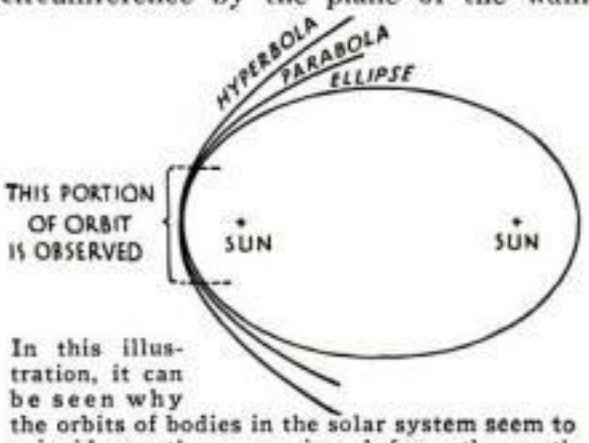
Below are the three curves followed by celestial bodies, the most frequently found being the ellipse. At right, a ball of steel, representing a planet or comet, is blown across a smoked glass toward an electromagnet, representing the influence of the sun

By
Gaylord Johnson

An odd thing about these three curves is the fact that they can all be produced by slicing through a circular cone at various angles.

Since the easiest kind of cone to make and slice through is the cone of light sent out by a flashlight, let us use that.

Throw the cone of light against the wall at a slant. An ellipse is formed when the cone of light is cut through its entire circumference by the plane of the wall.



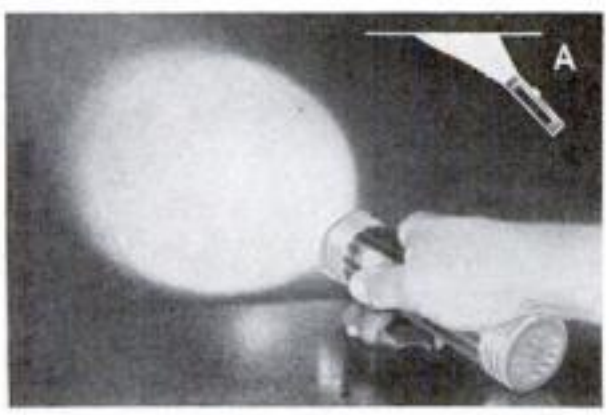
In this illustration, it can be seen why the orbits of bodies in the solar system seem to coincide as they are viewed from the earth

Direct the flashlight toward a corner of the room so that one side of the cone of light is parallel to the wall. The curve which the other side of the cone makes on the wall that cuts it is a parabola.

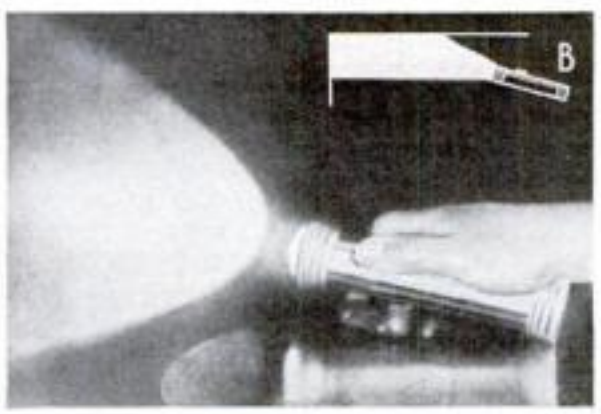
Finally, hold the flashlight with its axis parallel to the wall. Where the wall cuts the cone of light, parallel to the cone's axis, the beam outlines a hyperbola. If you want to roll out a little cone of clay or plastilene, and slice it in these same three ways with a knife, you will get the same three curves, which mathematicians call conic sections.

The gyroscope is useful in illustrating the very slow movement of the earth called precession. When the gyroscope is spun and placed upon its stand, the end of its axis describes a circle. The axis of the earth also moves in a circle among the stars, but requires 25,000 years to complete one revolution.

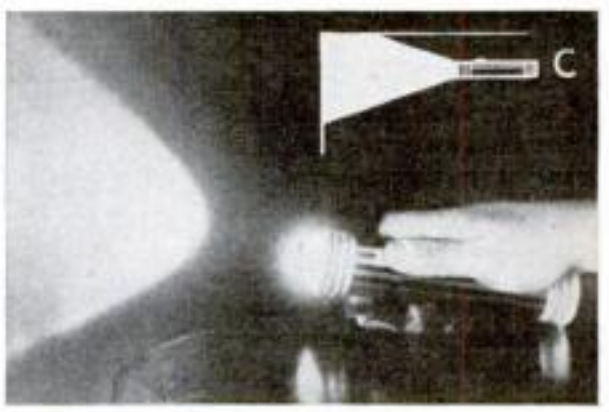
The experiments in the next article of this series will show how you can measure the sun with a pocket ruler; why the planet Saturn is surrounded by rings; why the earth's center travels in a 6,000-mile circle every month, and how to demonstrate that the so-called canals of Mars may be optical illusions.



When the rays from a flash light are thrown at a slant against the wall, an ellipse is formed as above, as the cone of light is cut by the wall

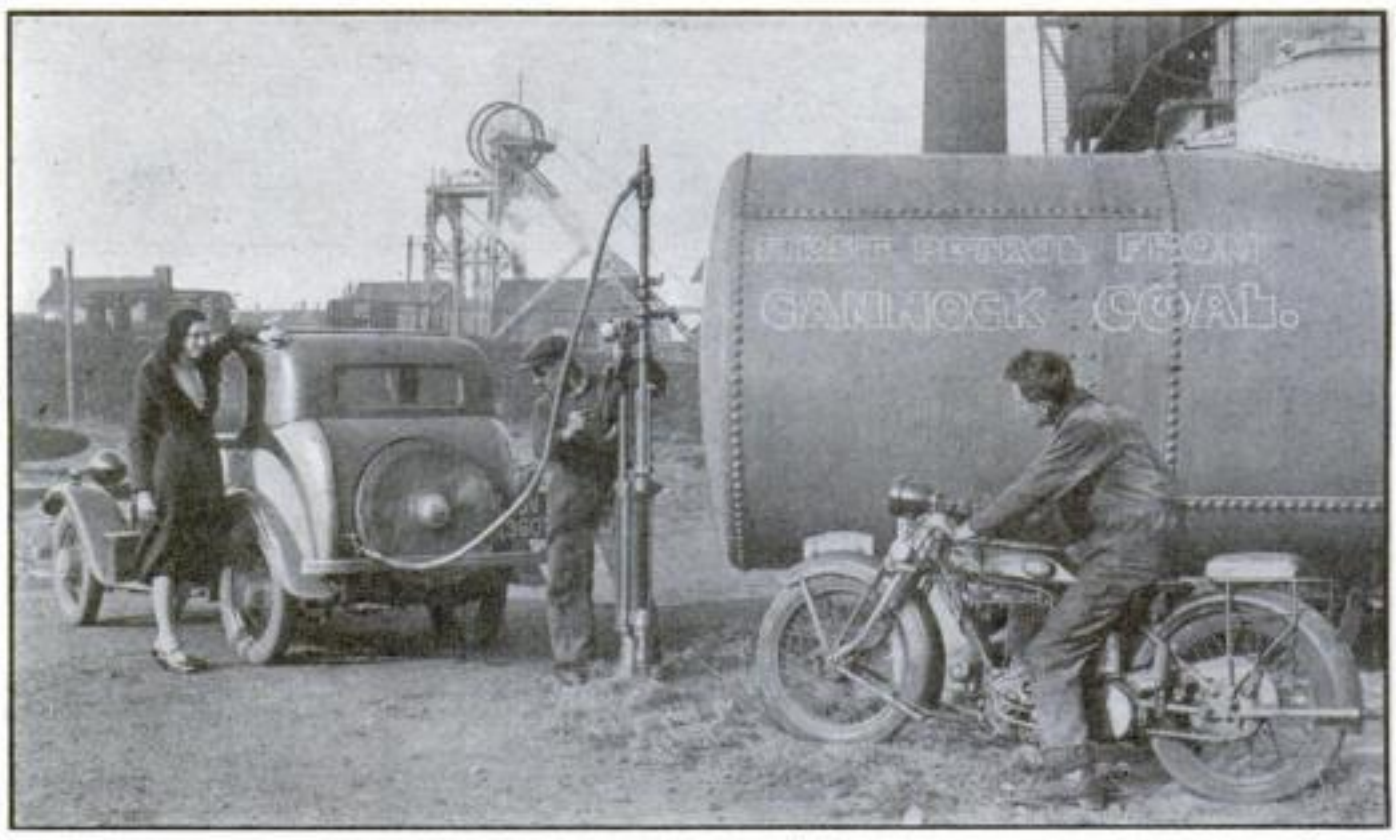


When the flash light is directed toward a corner of the room so that one side of its cone of light is parallel to the wall, a parabola is cut



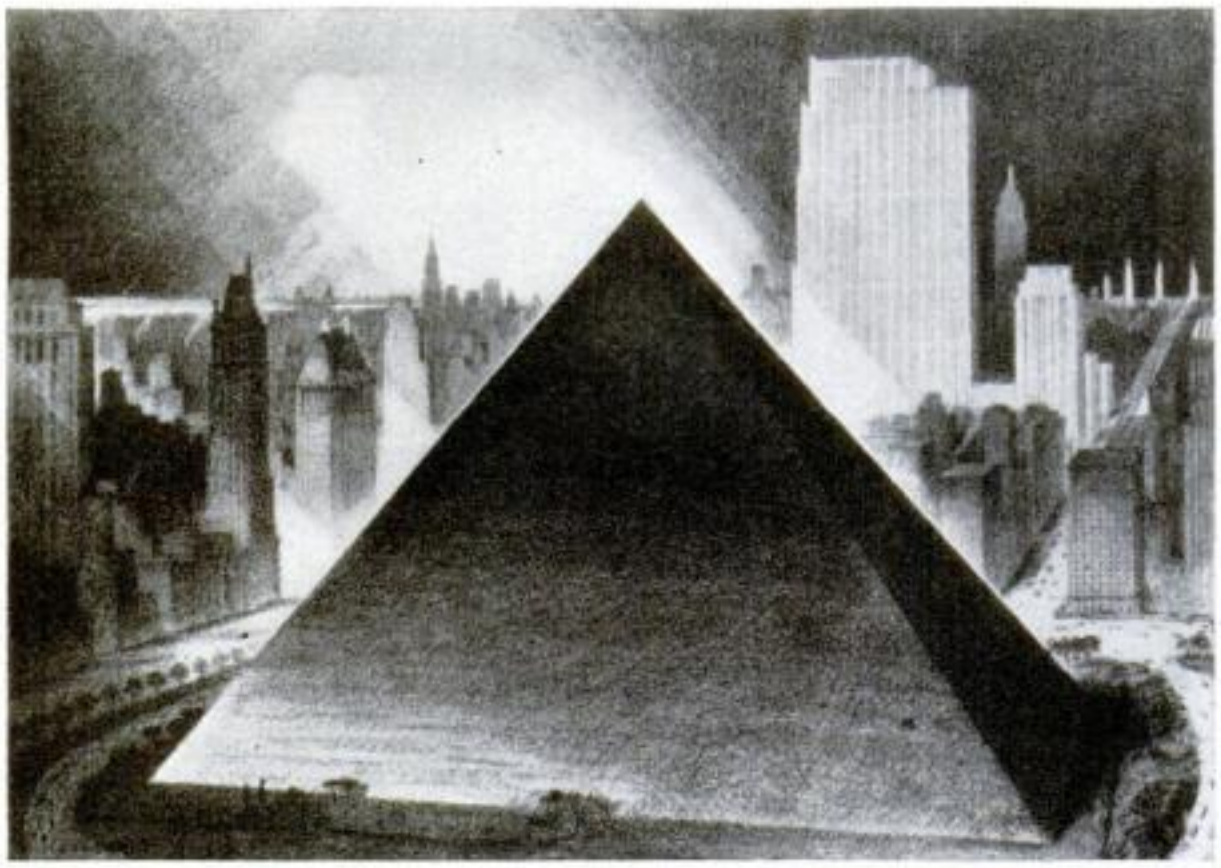
The axis of the flash light is held parallel to the wall. Where the wall cuts the cone of light, parallel to cone's axis, an hyperbola is outlined

England Now Has Gasoline Made from Coal



England has just placed on public sale gasoline made from coal. This picture shows one of the early purchasers of the new fuel having the car's tank filled. A plant, now building, will produce about 80,000 gallons a day

BRITISH motorists may now enjoy the novelty of buying gasoline made from coal, which has just been placed on public sale. The event marks the beginning of a great chemical industry by which England hopes to put 65,000 men to work and to end her dependence upon imported petroleum. A monster plant now rising at Billingham-on-Tees will transform 1,000 tons of coal daily into the synthetic fuel, using a process already in successful operation in a smaller experimental plant at the same site. In this process, known as hydrogenation, powdered coal is mixed with heavy oil and the resulting paste is fed, with hydrogen gas, to a converter. The mixture undergoes a chemical transformation under tremendous heat and pressure, yielding a mixture of hydrocarbons from which pure gasoline is recovered by distillation. Another of the products is Diesel oil, which may also be changed into gasoline by an additional conversion treatment with hydrogen. Both the hydrogen and heavy oil used in the process are obtained in the course of producing the gasoline, leaving coal as the chief raw material required. Results of production indicate that approximately a gallon of gasoline may be obtained from twenty-four pounds of coal, and the large-scale plant under construction should show an output of 80,000 gallons of gasoline a day.



COST OF PYRAMID PUT AT $156,000,000

IF AMERICAN builders were called upon today to erect a counterpart of the Great Pyramid of Cheops, how long would it take? How much would it cost? Would they recommend the same structural design? When these questions were suggested, the other day, to prominent New York architects and builders, they proved so interesting that three of them volunteered to make the necessary calculations. To reproduce the Great Pyramid in stone blocks like those of the original, they found, would be an engineering project requiring five and a half years. The cost would be $156,000,000. Labor needed would total 2,250,000 man-days, each of these units representing the work of one laborer during a working day. According to this estimate, the use of modern machinery would cut by nearly ninety-nine percent the labor required in ancient times, since historical accounts indicate the Great Pyramid took 180,000,000 man-days to build. However, modern architects could produce a durable pyramid at a much greater saving in labor and cost by substituting a skeleton of reinforced concrete, faced with limestone. Such a pyramid would cost $15,000,000 and require 750,000 man-days to erect.

NEW STORAGE BATTERY IN DIRT-PROOF CASE

COMPLETELY enclosed in a hard-rubber case of modernistic design, a storage battery of unusual appearance has been developed for motorists by a well-known manufacturer. The cover, according to the maker, excludes dirt, moisture, and stray fragments of metal that might cause short circuits. Power leakage and corrosion are thus prevented. Screw caps in the top of the case may be opened to add water to the cells, without disturbing the case. There are no projecting parts and recesses at each end of the case serve as handles.

SINGER CAN HEAR VOICE AS AUDIENCE HEARS IT

So that would-be singers may hear themselves as others hear them, a Los Angeles, Calif., voice teacher and former grand opera singer has invented and patented a voice reflector. Fitted around the pupil's neck like a collar, as shown above, its convolutions carry a part of the singer's tones back to her own ears. According to the inventor, his device will enable singers or public speakers to detect and correct faults in tone, volume, and diction during a few hours' practice, since they may hear in this way exactly how their voices in singing or speaking would sound to an audience.

ELECTRIC EYE REVEALS AD IN MIRROR

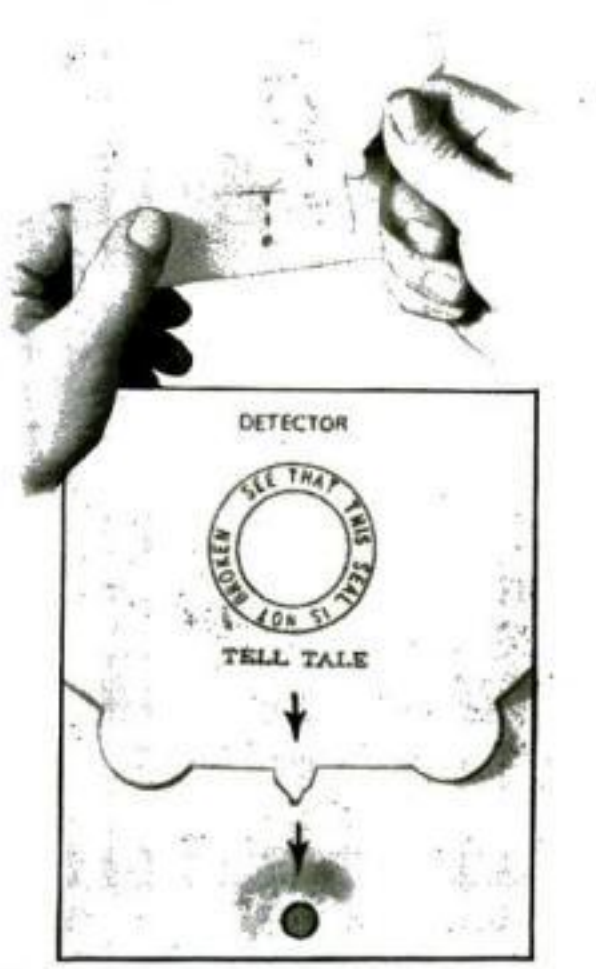
Right, a cabinet that apparently contains an ordinary mirror. When the passer-by reaches for a folder, an electric eye, as below, turns on a lamp that lights up an advertisement behind the transparent glass

DESIGNED to be installed in the lobbies of hotels and public buildings, a new advertising device offers a passer-by a chance to inspect his appearance in a mirror, and invites him to take a folder from a pile on a shelf. When he reaches for a folder, he unwittingly interrupts a beam of light that falls upon a photo-electric cell. Brilliant lights automatically flash on behind the mirror, which is now seen to be transparent, and illuminate an advertisement within the cabinet for a predetermined period of time.

MOVABLE TOWER HELPS HARVEST NUTS

WALNUT trees on the ranch of George Alcock, of Van Nuys, Calif., are so tall and large that shaking them proved an impractical way of collecting the nuts, so the resourceful rancher has invented what he calls a shaking tower to aid in the harvest. From a platform on top of this tower, men can reach out with poles and knock the nuts to the ground. Built of wood, the tower is twenty-six feet in height and has 126 square feet of working space on its elevated platform. It is mounted on runners so that a tractor may move it from tree to tree throughout the large orchard. Not only is the harvesting speeded up, because of the saving in labor, but a far more thorough job is done than would be possible from the ground. The platform is large enough for several men to work on.

From the top of this twenty-six-foot tower, workers knock the nuts from walnut trees in a California ranch. The tower, resting on runners, is moved about by means of a tractor



TAMPER-PROOF ENVELOPE

DEVISED by a Pennsylvania inventor, the tamper-proof envelope, shown in the top view, guards valuables and protects confidential correspondence from prying eyes. A gummed tab on the flap, moistened and inserted in a slit, blocks any attempt to pull open and re-seal the envelope undetected; while a tab of red dye inside causes a telltale discoloration to appear on the exterior, as shown in the lower view, if an effort is made to steam the envelope open.

Auto Top Raises to Make Room for Bed

SUITED to sightseeing by day and sleeping by night, an unusual automobile with a telescoping roof, has been built by Arthur S. Thompson and his son, of Ontario, Calif., for cross-country touring. When the day's drive is ended, two single beds are unfolded from the inner walls of the car, while a double bed, cradled at the normal height of the roof, provides sleeping accommodations for additional passengers. To make room for occupants of the latter, an electric hoist, operated from the dashboard, raises the whole roof with its duplicate set of windows, as shown in the photograph at right.

Two views of unusual touring car. Above, the top of the car hoisted up to make room for a full sized bed. Upper left, the car ready for the road

Bacteria, and other tiny microscopic creatures, are reproduced in models, like those shown below, to help blind students "see" them

BACTERIA MODELS HELP BLIND STUDY BIOLOGY

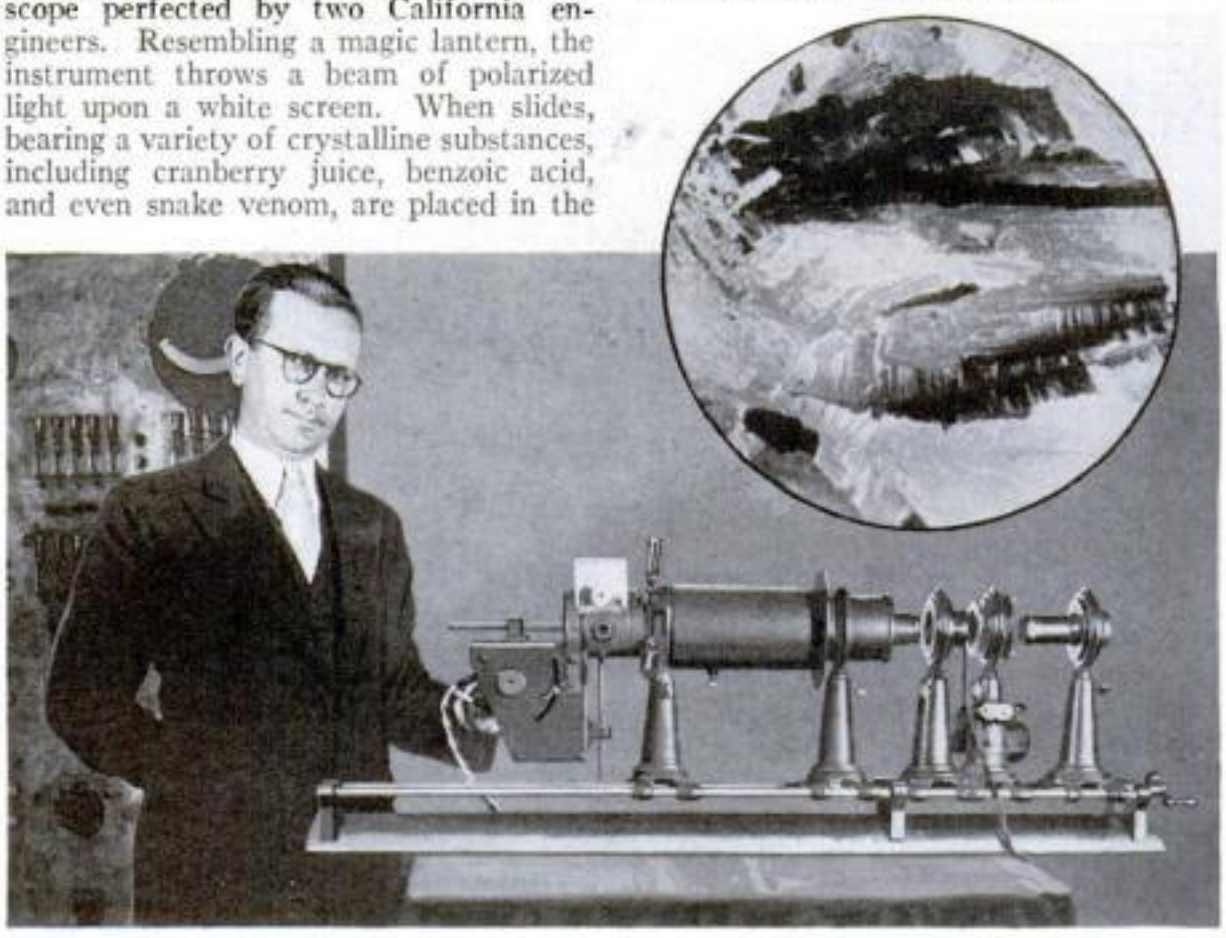
MICROSCOPIC marvels they cannot see are being made clear to blind students of biology at Baltimore City College, Maryland, through the use of models devised by Dr. Arthur H. Bryan, science instructor. The models, constructed of modeling clay, plaster, rubber, or wood cut-outs, are made by students who have the use of their vision, and are employed by the blind students of a class while the others are using microscopes. By running the fingers around the outline of the model it is easy to obtain a clear idea of the form of simple organisms such as bacteria and fresh-water animalcules.

CAMERA CAMOUFLAGED TO HIDE IT FROM BIRDS

TAKING a tip from wartime strategists, a Massachusetts naturalist has camouflaged his camera so that its presence will not be detected by his wild-bird subjects. Unless a card is held behind the camera, as at right, the camera is almost indistinguishable in a mass of foliage. A string, connected to bait, trips the shutter when the bait is seized.

BIG MAGIC LANTERN AIDS DESIGNERS

GORGEOUS patterns of color and form, in combinations never viewed before outside the laboratory, are placed at the disposal of designers by a monster kaleidoscope perfected by two California engineers. Resembling a magic lantern, the instrument throws a beam of polarized light upon a white screen. When slides, bearing a variety of crystalline substances, including cranberry juice, benzoic acid, and even snake venom, are placed in the path of the beam, rainbow-tinted images of rare beauty are produced. Designers and color experts are expected to find commercial use for the device.



This big kaleidoscope produced, on a screen, the image of snake poison, seen in the circle

Cylinders Replace Wings in Plane

JETS of air, sucked in at the front and expelled at the rear of huge tubes, are the unconventional means advanced by a Glendale, Calif., inventor for lifting and propelling an airplane. He has designed and patented a wingless craft, employing this principle, which he maintains will be able to rise and descend vertically and to hover motionless aloft. According to the inventor's plans, a propeller and motor are installed within each of two tubes, which in turn are so mounted above a standard airplane fuselage that they may be swung by the pilot to any angle. For a take-off, the tubes are to be operated in a perpendicular position, thus providing a vertical lifting force. Once in the air, the pilot would tilt the tubes ahead, in order to cause the plane to travel forward. An auxiliary propeller on the fuselage is provided to aid in forward travel, while rudders steer the plane.

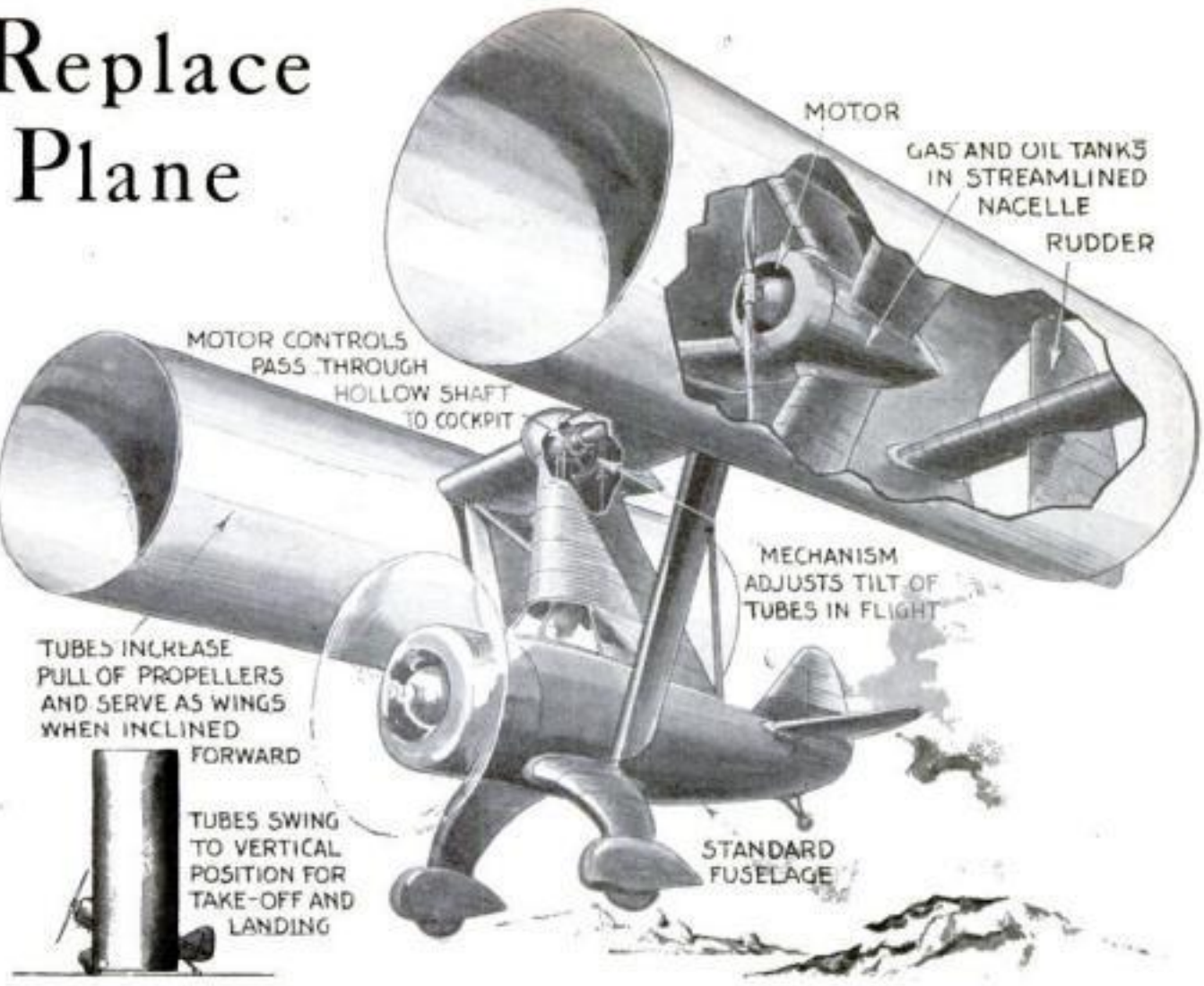
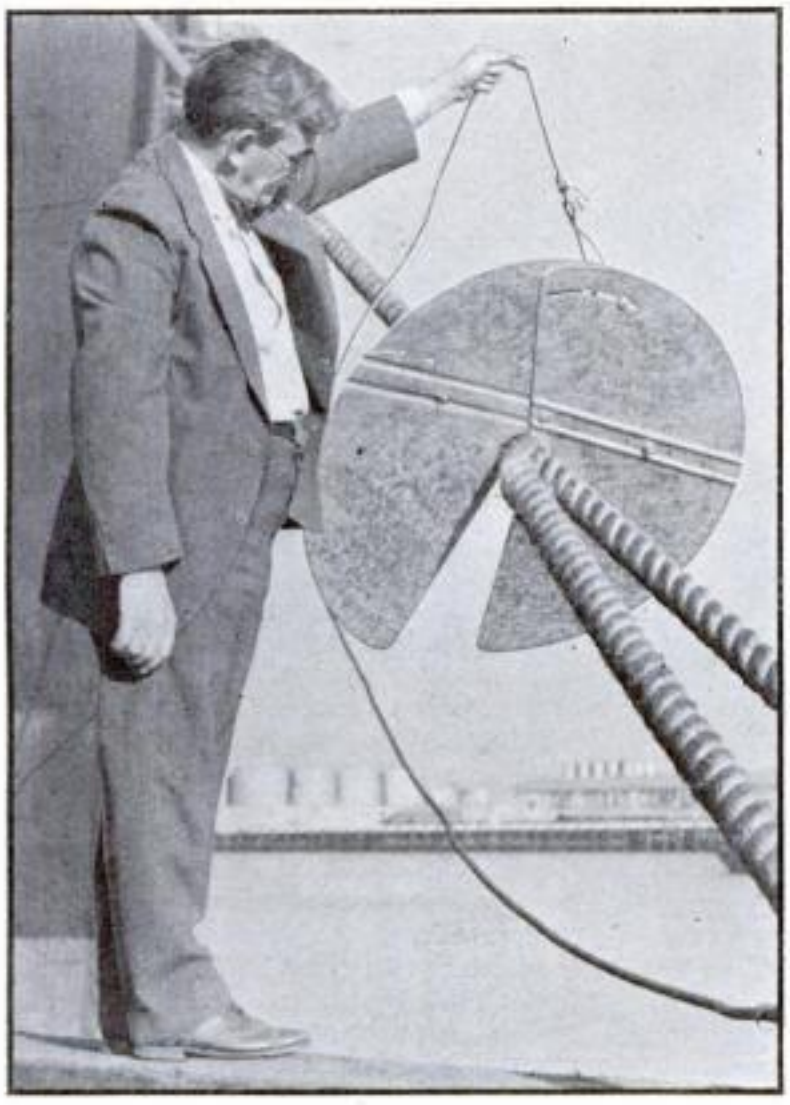


Illustration showing how wingless cylinder plane would be driven by jets of air forced out by motors in cylinders. Note, angle of tubes can be adjusted for take off or flight



ROPE WORKS SHIP'S RAT GUARD

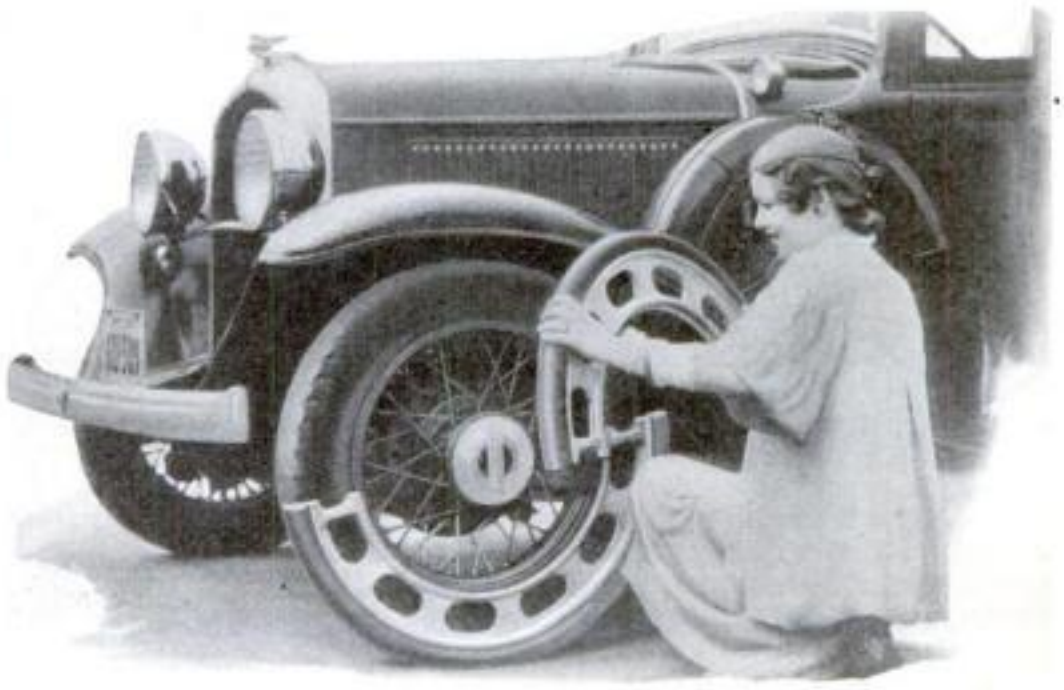
PLACING rat guards on hawsers, a necessary precaution against an invasion of rats while a ship is tied up in port, is made less risky for seamen by a safety guard devised by a California inventor. Handled by means of a small line, as demonstrated above, it may be applied to a hawser or removed without leaving the deck of a vessel. The two hinged leaves of the guard open when the line is drawn in.

VERSATILE CUTTING TOOL USES SAFETY RAZOR BLADE

HOLDING a standard safety razor blade, a new trimming tool permits the use of both hands for heavy work. Its sturdy handles may be assembled in eighteen or more positions, for various tasks. The depth of the cut is easily regulated.

RIM PROTECTS FLAT TIRE

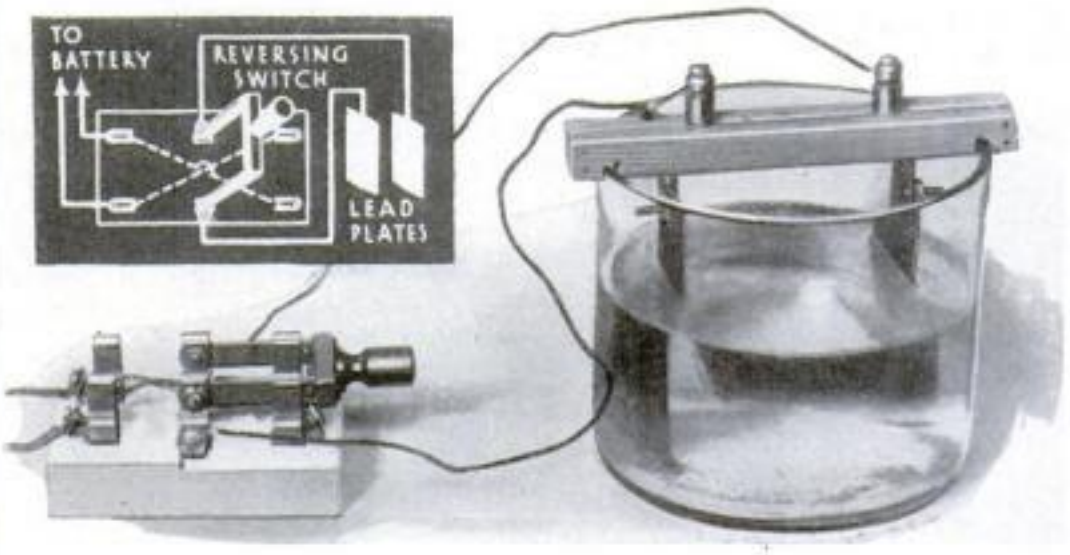
MOTORISTS are spared the trouble and muss of changing a flat tire by the roadside, through the use of an auxiliary rim recently placed on the market. Applied without jacking up the car or removing the tire, it provides a new riding surface and enables the driver to proceed home or to a garage, where a permanent repair may be effected at leisure. The rim comprises a pair of semicircular sections of aluminum alloy, encircled by a small tire of solid rubber. One of the sections is first slipped over the flange of the car wheel, and the car is driven forward a few feet, lifting the wheel from the road as shown below. The second half of the rim is then added and secured by two small bolts, completing the temporary repair.



By RAYMOND B. WAILES

Electroplating IN YOUR OWN LABORATORY

Metal articles, placed in a zinc basket, as above, and immersed in a suitable solution, can be plated without a battery



With this apparatus, arranged as shown at upper left, a current is passed through a baking soda solution to get white lead

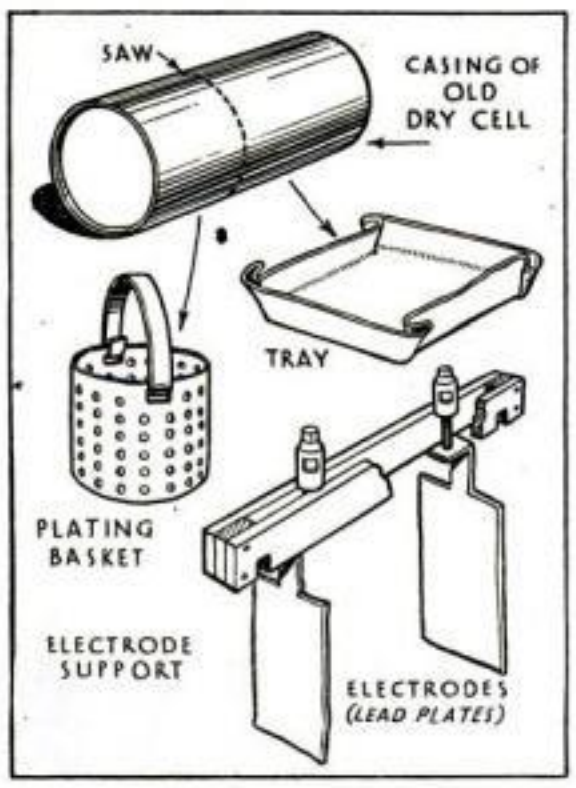
FOR surprises and thrills as well as practical uses, few sciences surpass electrochemistry. It combines the fascinating mysteries of two interesting subjects.

Our experiments with the tin tree and simple leadfoil storage battery (P.S.M. Dec. '32, p. 58) have shown us the close relationship between electricity and chemistry. Now, with the aid of a few feet of iron wire and a carbon rod, we can delve into the subject still further. We can use electricity to manufacture a queer metal known as lithium.

Unlike most metals, lithium is extremely active and floats on water. Skimming across its surface like a spinning top, it decomposes the liquid with a hissing noise. Even in ordinary air, it combines readily with the nitrogen. In fact, to store the metal safely it must be placed in a bath of kerosene.

In the home laboratory, this silvery substance can be formed by passing an electric current of about six volts through molten lithium chloride. The electric circuit consists simply of a carbon rod and a short length of iron wire connected to the terminals of a six-volt storage battery or three good dry cells connected in series. As in all electrochemical reactions, direct current is essential.

Place a small quantity of the lithium chloride in a porcelain crucible supported over a gas burner. When the chemical is molten, insert the carbon and iron wire electrodes. The carbon, connected to the positive terminal of the battery, forms the anode and the iron wire the cathode. As a means for collecting the metal as it is formed at the cathode, bend a small loop in the end of the iron wire.



Using the casing of an old dry cell, a zinc basket and tray, for use in metal plating without a battery, can be made as shown

When you have arranged the apparatus, turn on the current and watch the loop. A silvery substance will begin to form. This is the element lithium removed from the lithium chloride. To collect it, carefully remove the wire from the crucible, immerse it under kerosene in a dish or bottle, and shake it gently. This will dislodge the globule of lithium and preserve it for future use. Continue collecting the metal until several large drops have been obtained for use in the next experiment.

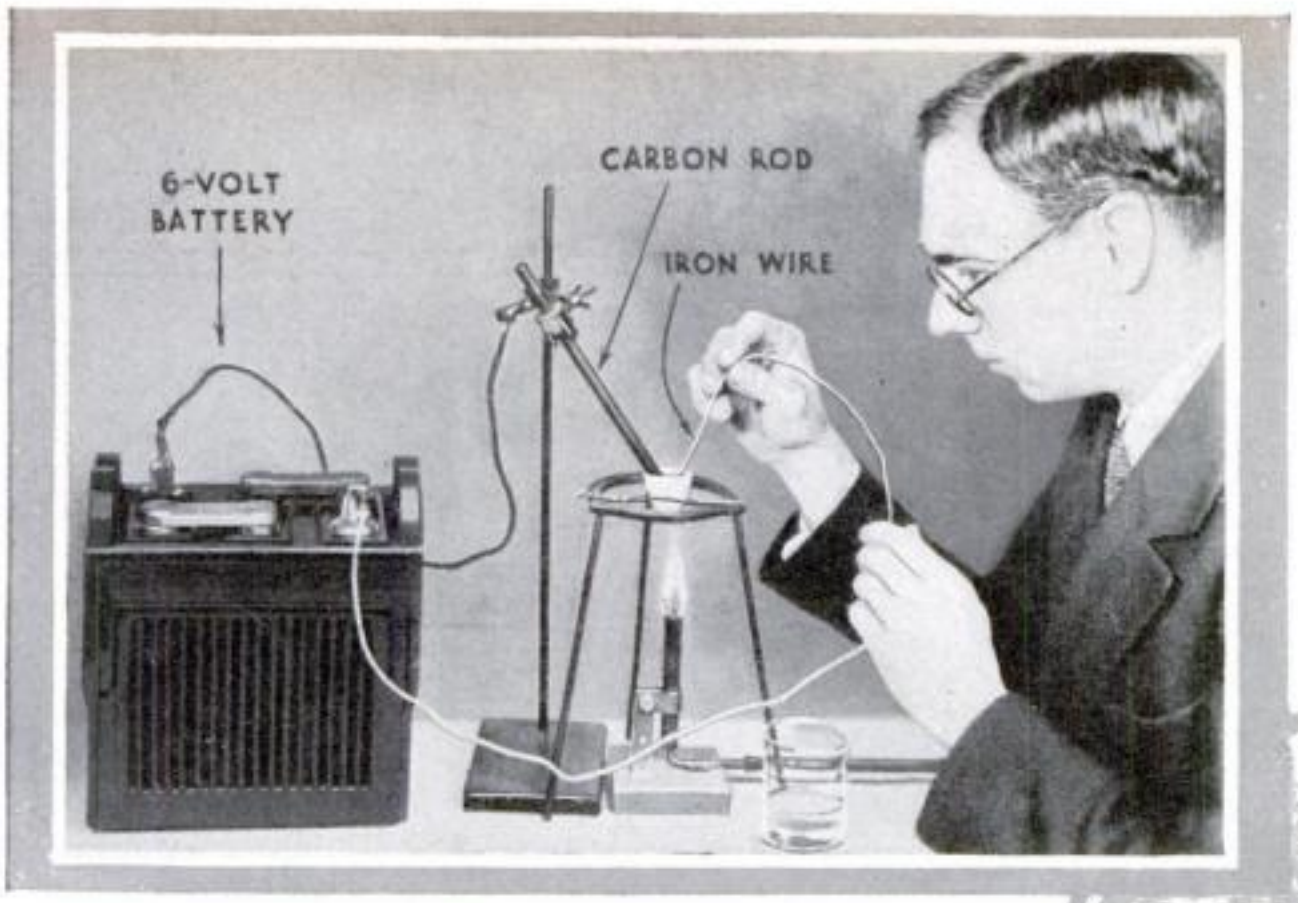
With forceps or a pair of tweezers remove a drop of the substance from the kerosene storage bath and place it in a beaker or dish of water. The drop will float, decomposing the water to form free hydrogen gas and lithium hydroxide. To prove that hydrogen is given off, bring a lighted match or a glowing splinter close to the spinning, hissing globule. The hydrogen formed will ignite and give an audible "pop."

The lithium hydroxide formed dissolves in the water to turn it basic or alkaline as will be shown by the fact that it will turn red litmus paper blue.

Using a somewhat similar electric circuit, you can manufacture small quantities of white lead. In this case, however, the two electrodes, consisting of sheets of lead, are connected to the terminals of the battery through a double-pole, double-throw switch so wired that throwing the switch arm from one side to the other reverses the current. The two lead electrodes can be mounted on a piece of wood for convenience. If the slotted support shown is used, more current can be made to pass through the solution by moving the electrodes closer together. In this way, the home chemist can make up for any deficiencies in the current source due to weak batteries.

The electrolyte, or solution in which the electrodes are immersed, is made up by dissolving about one tablespoonful of baking soda in a quart of water. Place the

Thrills, Surprises, and Utility in Electrochemistry Experiments at Home



Arrange your apparatus as shown above and pass an electric current through molten lithium chloride. In this way the home chemist can manufacture for himself a quantity of lithium for interesting tests

An easy way of plating with cadmium is illustrated at right. Copper or brass is rubbed with a cloth that has been moistened with a cadmium-chloride solution and then it is dipped in zinc dust

liquid in a wide-mouthed beaker (the bottom portion cut from a large bottle will do) and insert the lead electrodes.

When the current is turned on, you will notice that a white precipitate is formed around one of the electrodes. Soon the coating will become so thick that the current will find it difficult to attack fresh solution. At this point, throw the switch to reverse the current and cause the precipitate to be formed around the other electrode. This reversing operation should be repeated every five or ten minutes.

The accumulation on the bottom of the beaker will be white lead. To obtain it, filter the liquid, wash it with water while it is on the filter paper, and then dry it at a gentle heat.

Electroplating is one of the important uses of electrochemistry. Generally, the term implies the use of some outside current source to deposit a thin coating of metal on some other metal. The home chemist will find it easy to copperplate simple metallic articles merely by using copper-sulphate solution as the electrolyte, a sheet of copper as the anode (connected to the positive terminal of the battery), and the article to be plated as the cathode.

There is another and simpler plating process, however, in which no outside current source is used. The current required is generated by the conditions under which the plating is accomplished. It consists simply of placing the article to be plated in contact with a sheet of zinc and immersing them under a suitable plating solution or electrolyte.

The dissimilarity of the two metals causes an electric current to be formed. Being the more electropositive metal, the zinc acts as the anode and the metal in the solution is deposited on the article to be plated.

By experimenting with this process, the home chemist will find it a simple means of obtaining a thin, yet fairly durable, metal coating on any metallic surface. It is particularly valuable to the home mechanic and model maker who, for plating small parts, often desires a method that does not require a battery.

Although the coating formed will be thin, it can be polished and buffed and will take on a high polish. Of course, the durability of the plate can not be compared with that obtained by the regular plating method.

Basically, the process consists of placing the work to be plated, well cleaned, in contact with zinc in a suitable hot chemical solution. For convenience, the amateur can make an ingenious zinc basket to hold the work by using the outer shell of a discarded number six dry cell.

Cut the cell in two about three inches from its lower end. After the active paste has been removed, this will provide a shallow zinc cup or basket and sufficient additional zinc for a flat tray. Drill drain holes in the sides and bottom of the cup and fasten a zinc handle to its upper rim.

The parts to be plated are first cleaned of all dirt and grease and placed in the zinc basket or tray. The basket or tray then is immersed in the hot solution contained in an enamelled pan.

After ten or fifteen minutes, remove the basket from the solution and allow the liquid to drain off through the holes. Finally, immerse it in a bath of water to cool and clean the plated articles. The surfaces then can be buffed on a rag wheel or polished by hand with a suitable metal polish. This polishing or buffing is necessary to bring out the luster of the coating.

Of course, the compositions of the plating solutions or electrolytes will depend on the particular metal coating desired.

To plate a coating of zinc on copper, iron, or brass by this method, the electrolyte must consist of zinc-chloride crystals dissolved in water. The actual strength of the solution is not important.

Two solutions are available for use in nickel plating either copper or brass. One consists of twenty grams of nickel ammonium sulphate dissolved in about 500 cubic centimeters of water while the other is made up of fifteen grams of nickel sulphate and fifteen grams of ammonium chloride dissolved in 500 cubic centimeters of water.

By mixing ten grams of alum (potassium or ammonia alum) and two grams of tin chloride (stannous chloride) in 500 cubic centimeters of water, you can make an electrolyte for tin-plating copper, iron, and brass by *(Continued on page 102)*

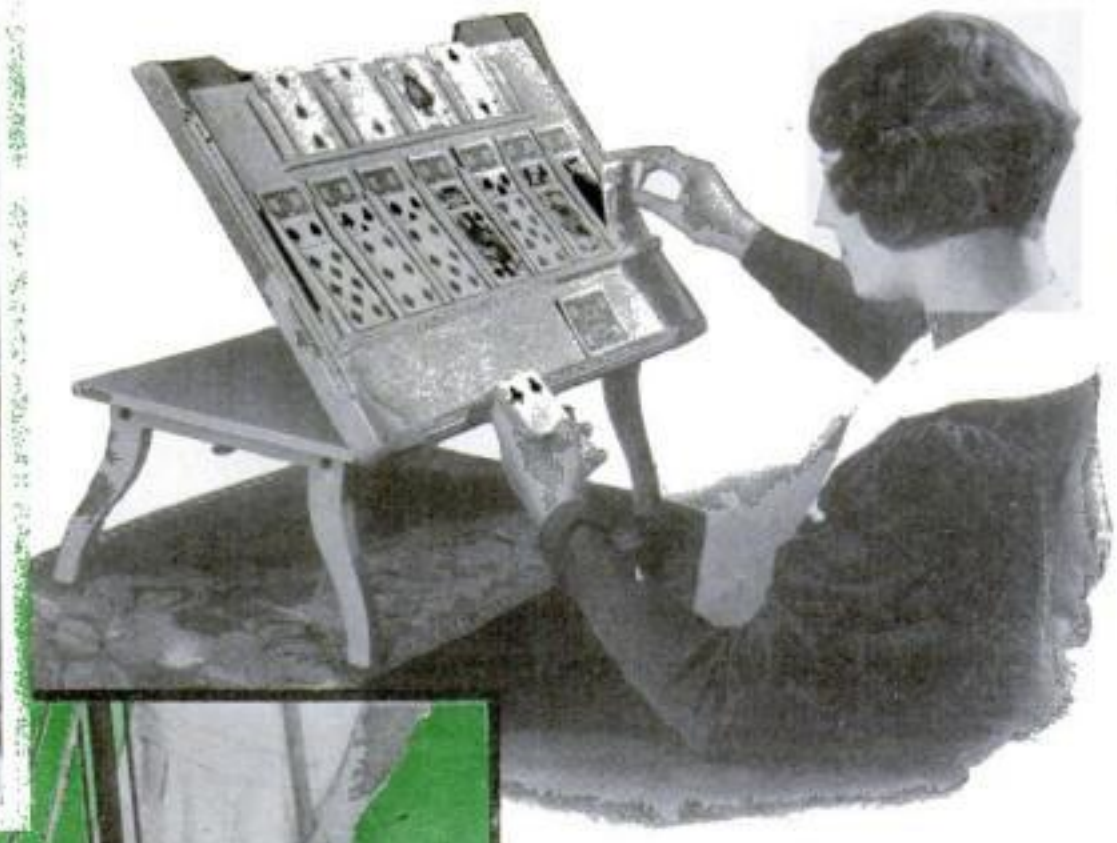
DO YOU KNOW YOUR Electrochemistry?

The answers to these interesting questions are given on this and the preceding page.

1. **Is it possible to electroplate without a battery?**
2. **What is lithium?**
3. **In electroplating, what always forms the cathode?**
4. **What kind of current must be used in electrochemical experiments?**
5. **What is an electrolyte?**

· Latest Conveniences

STARTS FURNACE FIRE. This portable gas torch expedites the chore of starting a fire in the furnace. Lighted with a match and thrust beneath the grate, it fires the coal



TRAY OR SOLITAIRE BOARD. This rack, when the top is flat, can be used as a breakfast tray. With the top turned as shown, it holds cards for game of solitaire

MAGNET IN CAN OPENER The arrow points to a steel magnet set in this can opener to attract small metal bits that otherwise might fall into the can

INDIVIDUAL TEAPOT. Each guest may have tea brewed to his personal taste, if these individual teapots are used. Pots are of glass so strength of tea can be seen

MOP QUICKLY CLEANED

When attached to vacuum cleaner, as shown in top view, this dust pan will remove the dirt from a mop when the mop is moved across it. When disconnected from the cleaner, the dust pan as shown above, can be used as an ordinary dust pan and can be emptied by attaching it to vacuum cleaner

LAMP PINNED TO WALL. Thumb tacks that are easily pressed into the wall are supplied with this lamp. By their means, the lamp can be put in any desired position and moved at will

MORE REFRIGERATOR SPACE

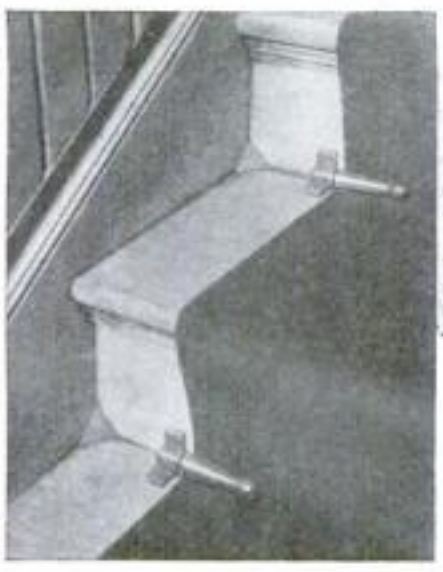
Placed on top of your refrigerator, the insulated chest, shown at right, provides additional storage space for foods. Surplus ice cubes are used to cool it

for the HOUSEHOLD •

A DEFROSTING BAG. Electric or gas refrigerators are defrosted by means of this rubber bag put around chilling unit. It removes frost in from five to eight minutes

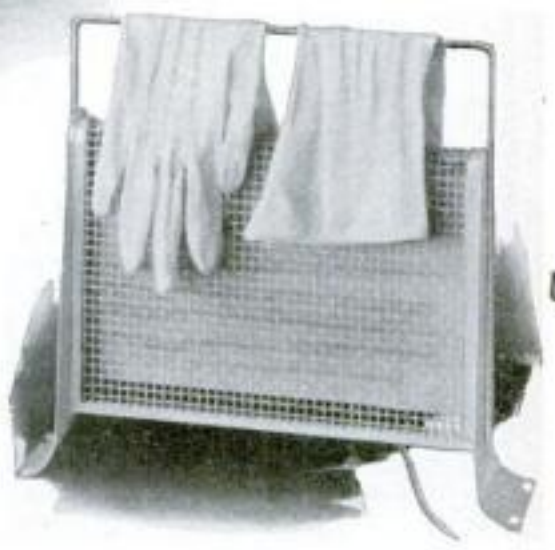
MILK BOTTLE A PITCHER

Slipping this attachment over a milk bottle converts it into a pitcher. Milk is poured from the spout by means of the wire handle



DIRT COMPARTMENT CAN BE REMOVED

This sweeper has a removable dirt container that can be lifted out and its contents disposed of without danger of spilling. The sweeper can be used safely on Oriental rugs



DRIES YOUR GLOVES. When hung over this compact electric heater, wet gloves are quickly dried. Stockings and lingerie can also be dried on it without fear of damaging the fabric

HOLDS STAIR CARPET. Grips of colored plastic material will hold stair carpets in place. The holding pegs slip into triangular blocks and are kept secure by friction. Corner stops, in the same material, are likewise provided

STAND ATTACHED TO IRON

By using the attachment shown below, you can give your electric iron a built-in stand. When the button is pressed the iron is lifted clear of the board. Picking up the iron then releases the stand

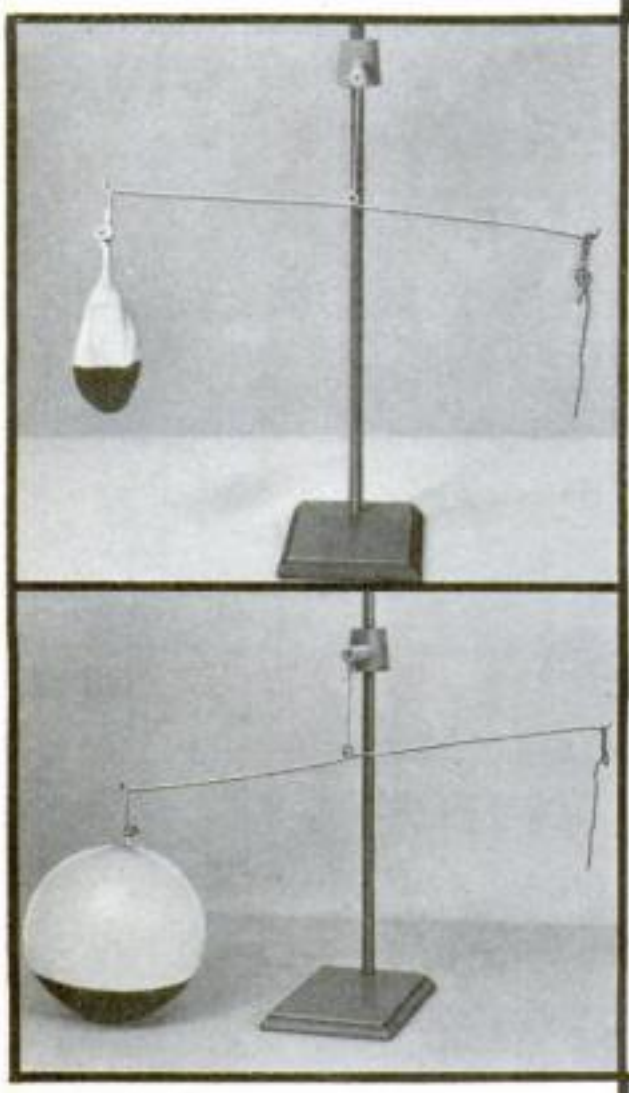
COMBINATION SERVING TRAY. This hospitality tray has a number of sections in which various foods may be placed. It also has an automatic electric toaster. A cutter at one side trims the toast and slices the bread to any size you desire

CLOSED ONION SLICER. This tumbler, with a slot in its side, is inverted over an onion which is sliced with a knife that passes through slot

Home Tests of Nature's Laws

You can demonstrate many strange laws of nature with the simple tests illustrated on this page. Two photographic plates, touching at one vertical edge and slightly separated at the other, as below, are dipped in colored water. The liquid will rise between them due to capillary action

To prove that water expands when it freezes and contracts when it melts fit a bottle with a stopper containing a glass tube open at both ends. Ice is placed in the bottle and water added up to visible level in the tube. Now as the ice melts you will see the water level in the tube sink

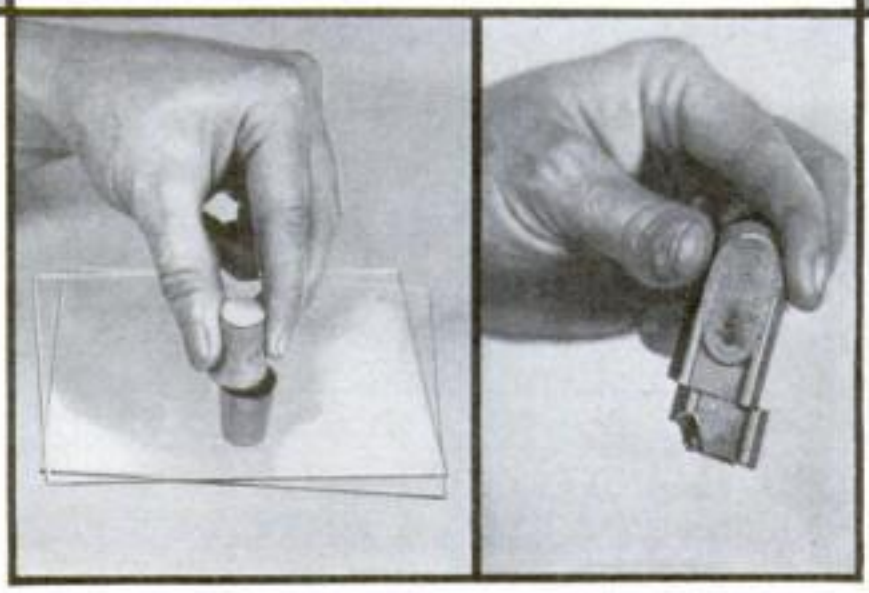


Water is densest, and therefore most buoyant, at about thirty-nine degrees, Fahrenheit. As its temperature rises above this point, it expands and loses some of its buoyancy. To prove this, weight a lamp bulb with solder so it will just float in cool water. As the water grows warmer, the bulb will sink. Then cool the water with ice cubes, as above, and the bulb will rise to the surface

Some cloth materials attract and unite with certain dyestuffs so avidly, that the remaining dye solution is left almost colorless. If surgical cotton is placed in a bottle of weak dye, like certain red inks, it will turn red and leave clear water behind. At right above, the dye before the cotton was placed in it, and left, the solution after use

You have heard and believe, that the air has weight. With the apparatus shown above, you can prove that this is so. Balance an empty toy balloon on a rod, as in first view. Then inflate the balloon and the bar will dip as in second view. This is due, of course, to weight of the enclosed air

The attraction that molecules of the same substance have for each other is called cohesion. This is the force that keeps solid objects from falling apart. You can demonstrate this strange force with two pieces of the same material. As seen at far right, a freshly cut bar of solder can be made to reunite by pressing the two smooth ends together. In the other view, right, two sheets of glass, fitted with cork handles, will stick together if one is pressed down carefully upon the other



Above is the model of a hot-water heating system. As the water in the glass tube is heated, it expands and rises. Then the colder, heavier water in the short tube on the left sinks, forcing the water from the right into the bottle. As this cools it will descend on the left, thus making the complete circuit. This is the principle of the system used in your car's radiator and in hot-water systems for dwellings

Hunting World Stations

This map, showing dial locations of short-wave stations (E.S.T.) in various parts of the world, will help you compile a list of stations. At right, globe and strip of paper used to figure time for any distant point

with a SHORT-WAVE SET

By George H. Waltz, Jr.

WITH the popularity of short-wave sets, converters, and all-wave receivers, the phrase "gunning for distance," has taken on a new meaning.

The shorter waves buzz with the activity of thousands of stations more than the broadcast channels ever boasted. Yet the haphazard dial spinning that is effective on the broadcast bands fails in short-wave distance hunting. To get the most out of your short-wave outfit, you must follow simple rules and a definite tuning technique.

First of all, the broadcast fan who is a beginner in short-wave reception should consider his antenna. A single wire draped on your roof or in the back yard may be just the thing for local broadcast programs and yet fall short of the mark when it comes to snaring the short-wave signals.

In the higher frequencies, man-made static becomes more of a problem. To be most effective, your short-wave antenna should be well insulated and rigged free of metal surfaces, electric lines, and buildings. Your lead-in must be protected against man-made noises, either through shielding or the use of a transposed type of lead (P.S.M., Nov. '33, p. 57). Finally, inside your house, long lead wires should be avoided by placing your set as close as possible to a suitable ground and the window that serves as an entrance for your lead-in.

Many owners of high-grade short-wave and all-wave receivers complain that neighbors with only a small superheterodyne and a simple converter bring in better distance. The trouble in most cases lies not in the set but with the operator. To bring in foreign stations on the shorter waves, you must tune carefully, patiently, and at the right time.

An up-to-date knowledge of station schedules is important. Team up with two or three of your friends who own short-wave outfits. Working together and exchanging notes, you can tabulate an impressive list of station locations and schedules in a short time. Start with the highlights given in the map on this page and use their dial locations to find others on near-by wave lengths.

When hunting out a new station, remember that most short-wave transmitters are experimental and are most active between five and twelve o'clock in the evening, *local time*. The fact that a time difference exists between various points in our world makes it possible for the short-wave distance fan to search for stations with darkness to help him. Light has a deadening effect on certain radio waves, particularly on wave lengths above thirty meters.

Because time differences and locations are important factors in short-wave work, a few dollars spent for a good eight- or ten-inch diameter globe of the world will be a good investment. With it, you can figure air-line mileages to add to your log and compute accurate time differences.

To measure the radio distance between your location and London, England, for instance, stretch a piece of string between the two points on the globe. The string will assume the great circle route radio waves travel and when compared with the scale on the globe will furnish you with an accurate distance in miles.

If your globe has no scale, arrange one by stretching a string around its equator and dividing it, with a pair of dividers, into fifty equal parts. Since the circumference of the world is approximately 25,000 miles, each division on your string scale will span 500 miles.

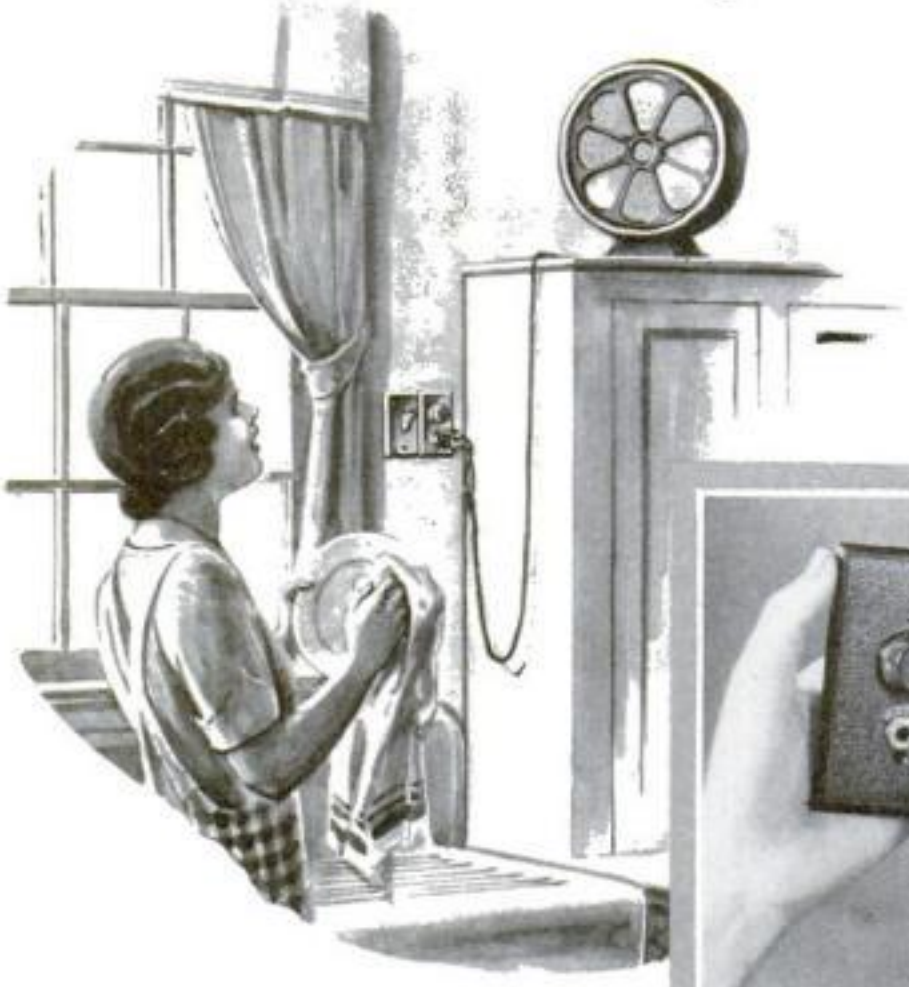
To figure time differences, cut out a strip of flexible paper (black is best) about a half inch wide and longer than the half circumference of your globe. Mark off the exact half circumference and divide it into twelve equal parts. When placed along the globe's equator, each division will indicate a one-hour change.

For convenience, number each division in hours, beginning at the extreme left with seven and continuing to the right through twelve to six. By placing the scale along the equator so that the desired time coincides with the fifteen-degree meridian passing through your locality, you can figure the converted time for any point in the same hemisphere.

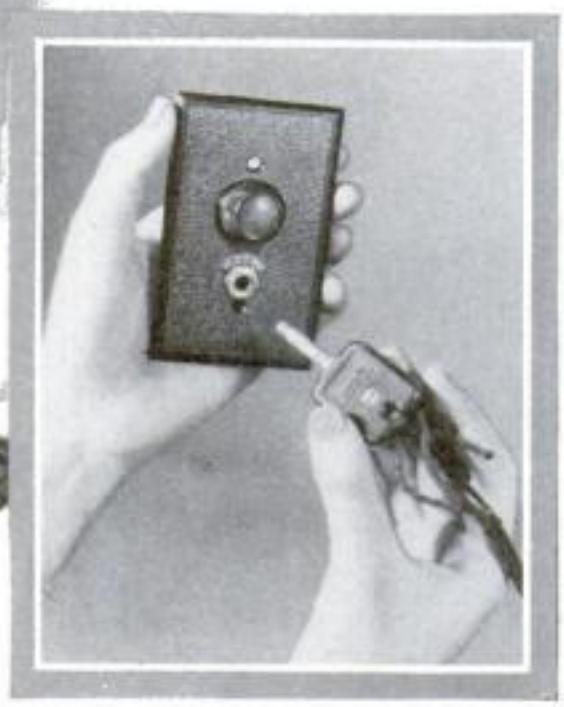
In the same way, the time conversion scale will help you follow night around the globe. Covering a span of twelve hours, it will show graphically what portion of the earth is clothed in darkness.

Auxiliary Loudspeaker

An extra "voice," easily added to your set, permits you to hear your favorite programs upstairs, downstairs—where you want them



An easily connected second loudspeaker will bring your favorite radio programs into your kitchen or into any room you may desire



This commercial combination volume-control and speaker-jack wall plate will serve as an attractive outlet for a second speaker

For a portable control, the two wall plates can be mounted in a wood box

HAVE you ever wished that your radio had two speakers—one upstairs and the other downstairs?

By salvaging the dynamic or magnetic speaker from an antiquated set, you can provide yourself with just such a unit. Wiring the extension for the auxiliary speaker consists simply of making connections to the primary of the speaker transformer in your set. If the speaker you intend to add is of the dynamic type, this will have the effect of connecting the two transformers in parallel.

When these connections have been made, hunt out the voice-coil leads of the dynamic speaker in the set, cut one lead, and insert a single-pole, single-throw switch. This will provide a means for silencing the main speaker at the set when only the remote speaker is desired. You will have little difficulty locating the voice-coil leads if you will remember that they are small wires leading to the base of the speaker diaphragm or cone (P.S.M., Sept. '33, p. 55).

The extension wires leading to the second speaker (twisted lamp cord or similar wire) then can be run along the baseboards to the desired room, insulating staples being used to hold it in place. If desired for safety, a four microfarad condenser can be placed in each extension lead. For a completely hidden job, the wiring can be planned as a regular house-wiring circuit, being run through the walls and floors in armored cable.

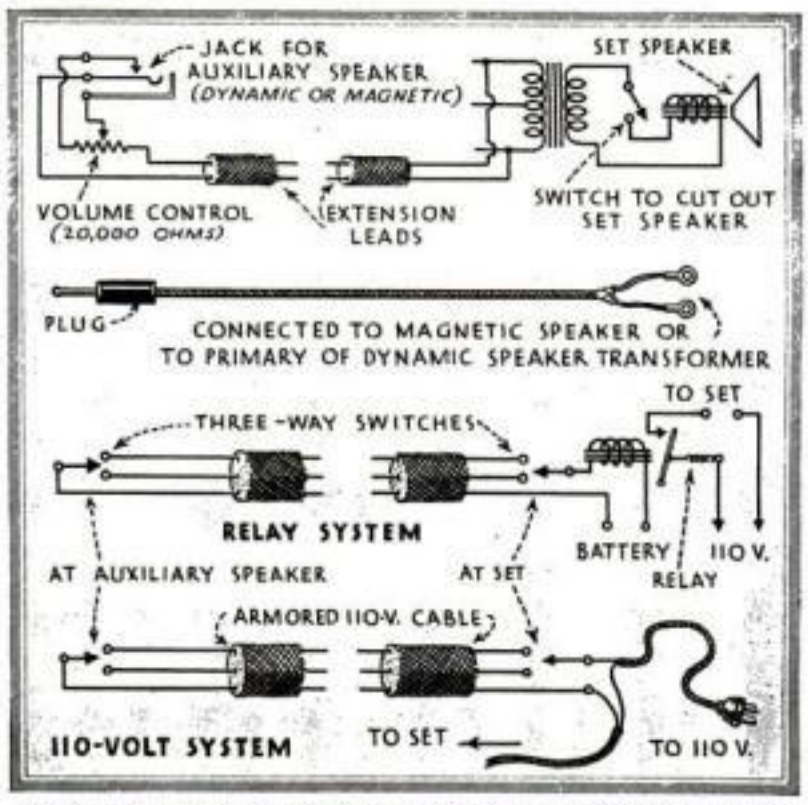
To allow the volume of the second speaker to be controlled independently of the receiver, place a 20,000-ohm potentiometer in the circuit at the outlet as shown in the diagram. For convenience, the output can terminate in a three-contact jack, the leads to the speaker being supplied with a plug. If an ordinary double contact jack is used, it will be necessary to employ a potentiometer provided with a built-in switch so that the resistance will be cut out of the circuit when the speaker is not being used.

If desired, a combination jack- and volume-control wall plate can be used as the auxiliary output. This consists of a simple two-contact jack and a potentiometer with built-in switch mounted on a composition or brass plate.

With an arrangement such as this, the speakers can be used either separately or simultaneously. To use the remote speaker by itself simply turn up the volume control at the set, open the voice-coil switch, and adjust the auxiliary volume control to the right level. The set, of course, first will have to be tuned to the desired station. When the second speaker is not in use, turn the volume control to the "off" position, remove the speaker jack, and close the receiver voice-coil switch.

Your installation will not be complete, however, until you have provided some means for turning the set on and off from the remote speaker as well as at the receiver. The simplest way to do this is to use a variation of the three-way switching arrangement used in house-wiring circuits to control a hall light from either of two points.

Although the remote switching arrangement can be wired directly into the 110-volt supply to the receiver, this would require a regular wiring job. A simpler way is to use the three-way switches to operate a battery relay which in turn controls the 110-volt supply circuit.

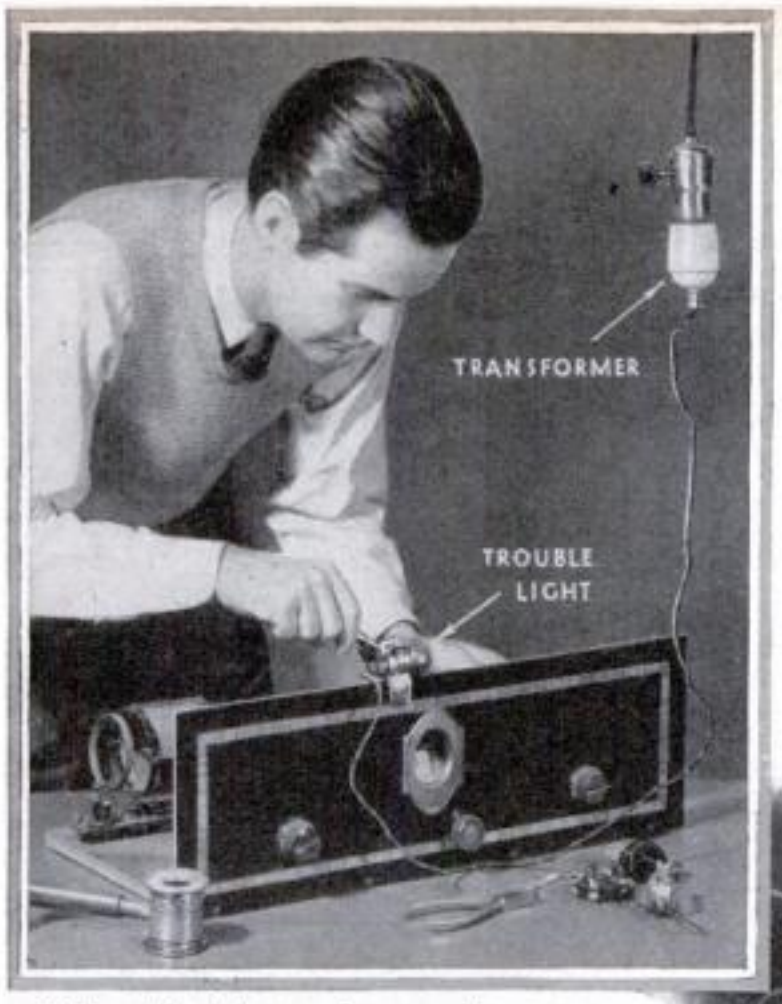


By following these diagrams, you can connect an auxiliary speaker to your receiver and provide a good remote switching arrangement

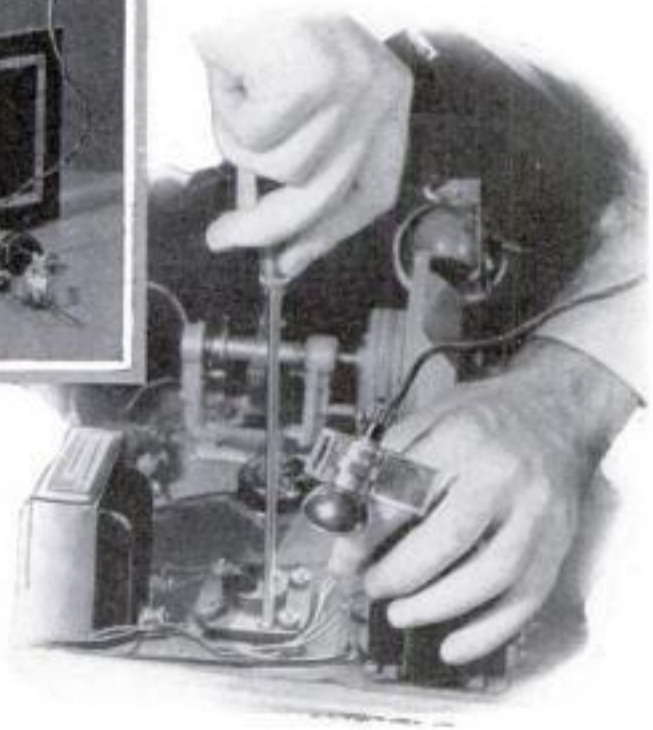
Trouble Light

FOR RADIO WORKERS

Transformer and Extension All You Need to Build Valuable Accessory



With a pilot-light transformer and an extension for a flashlight, you can make the trouble light illustrated above. At right, the light is seen clipped to finger of left hand



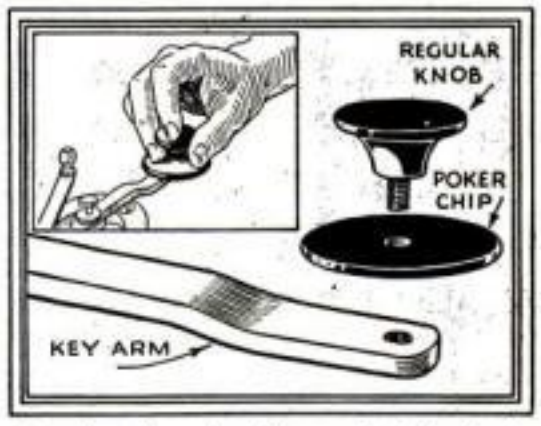
TO BE of real value, the radio experimenter's trouble light should be small, portable, flexible, and inexpensive. By combining two easily obtainable parts—a small plug-in transformer and a flexible wire flashlight fixture—you can provide yourself with just such a lamp. The pilot-light transformer, fitted with two plug prongs and sold as a night-light device, can be inserted into any wall or baseboard receptacle. At its outer end is a small lamp; a three-and one-half-volt bulb. Simply unscrew this and substitute the miniature screw plug on the end of the flashlight-fixture wire, screw the tiny bulb into the shaded socket, and your portable trouble light is ready for use. Being fitted with a spring clamp, the light socket can be placed where it will do the most good. If you are testing or repairing a set, you can snap it on the panel or on one corner of the chassis. When using a screw driver or other tool in a crowded, poorly lighted corner, it can be clipped to the first finger on your left hand. Its portability, coupled with the fact that it can be plugged into any 110-volt alternating current house circuit, makes it particularly useful as a trouble light for service men.—W. A.

Novel Station Cards

NO HAM station is complete without a supply of station cards. Requests to "QSL" will come as soon as you go on the air. Feeling that the usual acknowledgement, a plain postal card bearing the station letters and spaces for the usual information lacked in originality, the writer devised the photographic card shown at the right. First, a suitable decorative background must be selected for the card. In the case of the card shown here, the decoration was an advertisement clipped from a magazine. Select an illustration that will furnish enough blank space to take the station call letters which are lettered in black drawing ink.

Place a good photoflash picture of your station in one corner of the illustration and letter in your address in the other corner. When the three units are fitted and assembled in a regular eight-by-ten-inch printing frame you are ready to make the copies. To make the master copy negative, focus your camera on the assembled original and light it with two 100-watt lamps in suitable reflectors. Once your master negative is made, you can print as many copies on post-card size paper as you need. Then, for a few cents, a printer will print the usual titles on the reverse side of the card.—W. H. F.

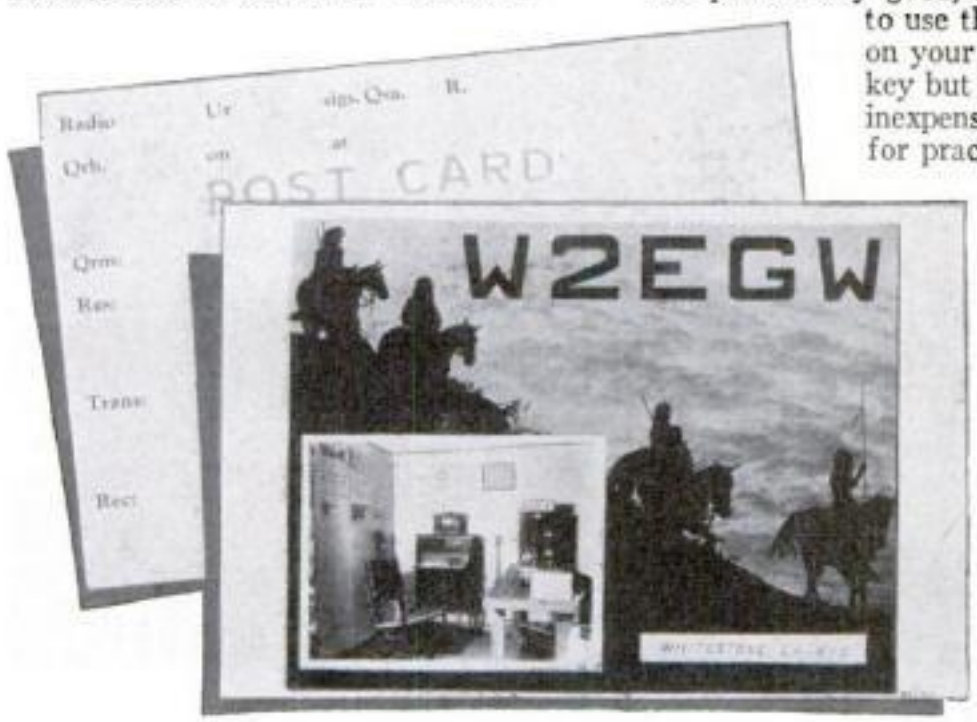
Fashioning a Navy-Grip Sending Key



A poker chip, placed beneath the knob of your practice key will give you a good navy-type grip to use in learning to send

Improving Practice Key

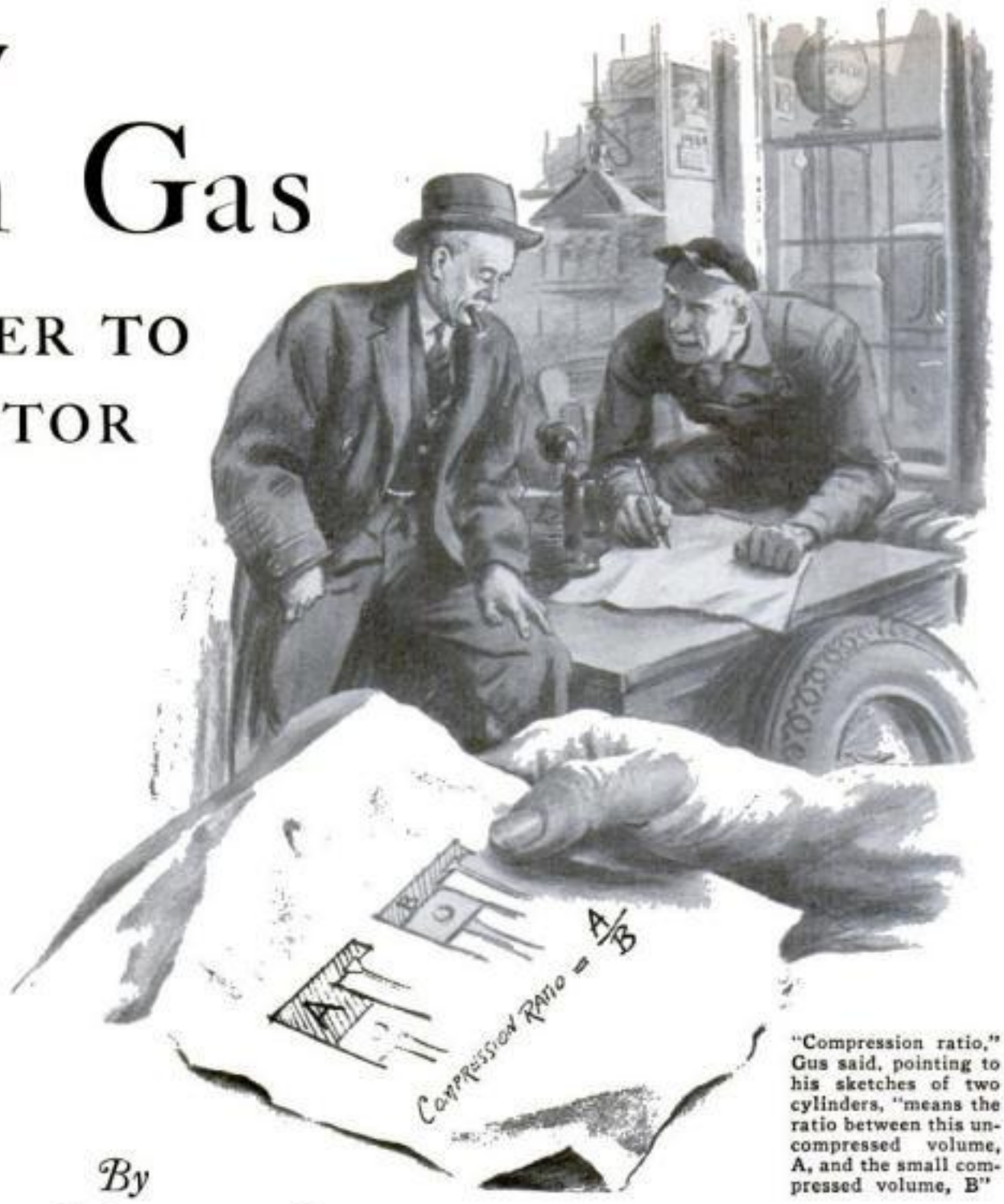
IF YOUR code practice key is fitted with a knob grip, you can convert it into the navy type by adding a cardboard poker chip. Drill a small hole in the center of the chip, slip it over the threaded portion of the single knob, and screw the complete assembly back in place. The poker chip combined with the regular knob will form the double grip that makes the navy-type key so easy to use. For appearance, paint the chip black to match the original rubber knob and apply a coat or two of shellac to provide a glossy finish. Because the insulating qualities of the compressed paper that forms the chip are not particularly good, it is not advisable to use this homemade grip on your actual transmitter key but it does provide an inexpensive double knob for practice.—L. H.



MAKE YOUR OWN CARDS

At left is shown an original station card made by photographing a card upon which was a suitable illustration, the station's call letters, and the address. This card is inexpensive to make

How Modern Gas ADDS POWER TO YOUR MOTOR



"Compression ratio," Gus said, pointing to his sketches of two cylinders, "means the ratio between this uncompressed volume, A, and the small compressed volume, B"

By MARTIN BUNN

CLIFF MACDONALD had dropped in at the Model Garage for a noon-hour chat with his old friend Gus Wilson.

"By the way, Gus," he said jerking a thumb toward the gasoline pumps that stood in a line outside the garage office window, "what's your idea of the perfect gasoline?"

Gus Wilson had just finished his lunch and was poking tufts of black tobacco into the charred bowl of his favorite pipe.

"Your guess is about as good as mine," he replied as he struck a match. "Why do you ask?"

"Well, years ago, gasoline was just gasoline," said MacDonald. "But now every brand advertises some new feature that's supposed to make it better than all the rest. Why, they've even gone so far as to put the stuff out in different colors."

Gus chuckled as he found himself a seat on a corner of the office desk.

"You're getting more for your gasoline dollar today than you ever got before," he pointed out. "Gasoline had to change to keep up with the times. You know, automobiles aren't as simple as they used to be either."

"Well, the bodies may have changed but I don't see where the motors are much different," MacDonald maintained. "They may be a trifle faster and more powerful but—"

"And that's the answer," interrupted Gus. "It's that extra power and added speed that's back of the whole business. Car horsepowers have increased over seventy-five per cent in the last eight years."

"Sure, but that's a question of motor design and not gasoline." MacDonald argued.

"Not entirely," Gus corrected. "It's true that one way to get more power is to build a larger engine and feed it more gasoline. But when the public started its howl for more power and speed, it didn't want a heavier engine. In fact, they wanted a smaller one that would use less gasoline. So automobile engineers had to compromise.

"First of all, they knew that by putting the air and gas mixture in the cylinders under more pressure they could get more power with the same amount of gas so they worked along those lines and developed the high-compression motor. By making the space in the cylinder head smaller, they increased the compression."

"So that's what they mean when they say that the modern motor has a higher compression ratio than the older ones?"

"Exactly," agreed Gus as he picked up a scrap of wrapping paper and proceeded to make rough sketches of two cylinders; one with the piston at the top of its stroke and the other with the piston at the bottom.

"Compression ratio," he explained pointing to his sketches, "simply means the ratio between this large uncompressed volume (A) and this small compressed volume (B). In other words, it tells the number of times that the mixture of air and gas is compressed by the up stroke of the piston. Ten years ago plenty of cars had compression ratios as low as three to one. Today, some go higher than six to one. In 1923, only about four percent of cars had a cylinder pressure over one hundred pounds. Now, ninety-three percent of the cars operate at that pressure."

"How about gas mileage?" put in MacDonald. "I should think a high-compression motor would use more fuel."

Gus shook his head. "As a matter of fact," he pointed out, "a good high-compression engine will deliver more power for less gas. But the engineers ran into a snag with their high-compression motors and that's where the new gasolines come in.

"Years ago, gasoline used to be obtained from the crude oil by a simple method of distillation. You know, like moonshine whiskey; simply boiled and then condensed. That kind of gasoline worked fine in the older motors but when they put it in a high-compression motor, it made all kinds of noises and wouldn't give any power."

"What caused that?" MacDonald asked.

"The increased pressure in the cylinders. Instead of burning slowly and pushing the piston steadily, it exploded. That gave the piston a sudden punch that lacked power and caused a 'pinging' knock.

"Naturally, if high-compression motors were to be a success, something had to be done about it, so the gasoline chemists tinkered around until they made a discovery. They found that if instead of distilling the crude oil they placed it in a closed container under pressure and heated it, like the vegetables in a pressure cooker, they obtained an entirely different gasoline. They called this process 'cracking' and its product was found to burn quietly in a high-compression motor. After a little more fussing around, they finally brought out the modern anti-knock gasoline. Some chemists even added a chemical, tetra-ethyl lead, to make it burn still more evenly."

"But what's this octane rating you see and hear so much about these days?" MacDonald asked. "Sounds like the name of a gas or something."

Gus smiled. "It's not, though. It's simply a number, like degrees of temperature that des- *(Continued on page 99)*

HOW TO BUILD A

iniature tage

...A Fascinating Hobby for All Who Enjoy Theatricals

Above: Complete stage with the valance, front curtain, grand drapery, tormentors, wood drop, two wings, and border. *Left:* Without the front

By Benjamin W. Hicks

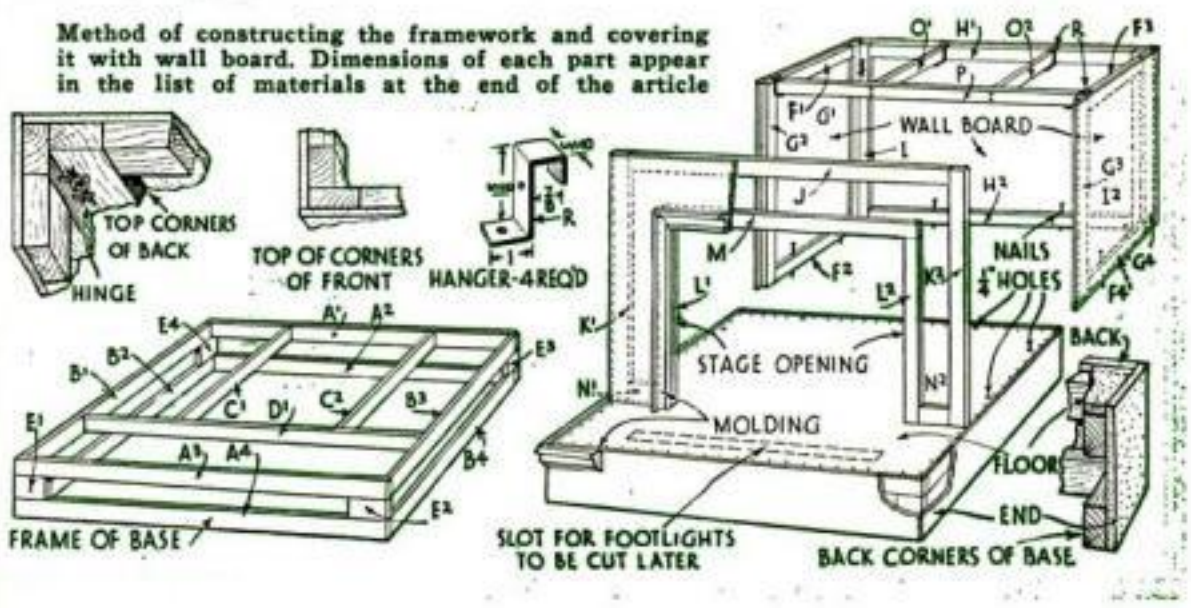
IF YOU have fallen under the spell of the footlights and wish to make theatrical work one of your hobbies, here is a chance to build your own miniature stage at very little expense. With it you will be able to develop all sorts of settings, equipment, and lighting effects, just as if you were a professional scenewright. It would be hard to find a more genuinely fascinating and satisfying pastime.

This miniature stage is built to the scale of 1 in. equals 1 ft. and is 46½ in. wide, 40¼ in. high, and 30½ in. deep over all. The construction is such that it can be taken down and stored in a closet when not in use. It also can be carried in a car without any trouble, thus making it convenient for a scenery salesman or those who are engaged in amateur or professional theatricals and have to travel.

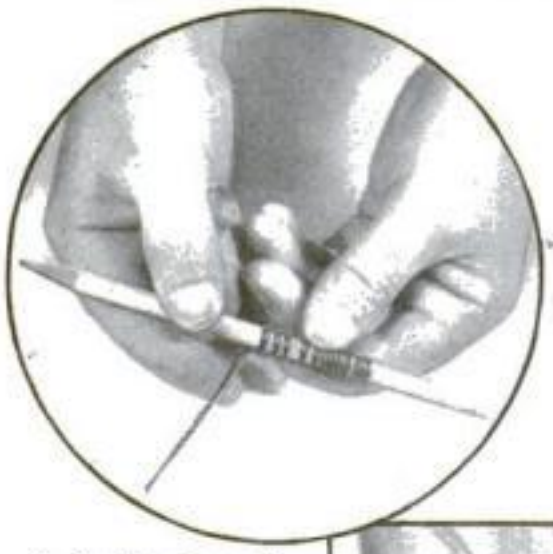
The stage designer in schools and other play-producing organizations will find a miniature stage useful when planning settings, because he can make an exact model to scale, set it in place, and see if any mistakes have been made in color or design. He can also see how the lighting will act on the different colors used in painting without the expense of building large sets for experiment.

After cutting *(Continued on page 94)*

Method of constructing the framework and covering it with wall board. Dimensions of each part appear in the list of materials at the end of the article



Mysterious Wire Coils Seem to be Endless



A double piece of No. 20 copper wire about 15 in. long is wound on a pencil

The coil is then stretched out uniformly to a length of at least 10 in.

The coils are held as shown above and made to revolve by separating the hands

Wound in opposite directions, the two coils are meshed so as to overlap for about 4 in.

ONCE you learn how to do this puzzling but very simple little wire trick it can be performed anywhere without previous preparation.

First cut two doubled 15-in. lengths from a coil or spool of No. 20 bright copper wire. Wind each double length around a pencil to form two coils. What the audience does not notice is that each coil is wound in a different direction.

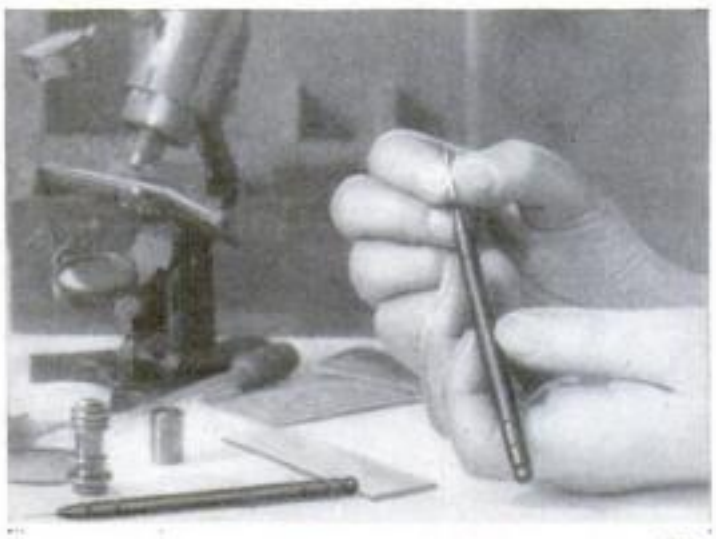
Grasping each coil by the ends, stretch it out uniformly to a length of about 10 in. Then mesh together 4 in. of the ends of the coils, one inside the other.

If the coils are held between thumbs and fingers as shown, you can make them revolve by separating the hands slowly. This produces the illusion that the coils themselves are being endlessly separated.

The trick is repeated several times; then crush the coils in the hands and offer the spool of wire and pencil to members of the audience with a request that they try to do it. Inasmuch as they will wind both coils in the same direction, they will find it impossible to duplicate the feat.—GEORGE S. GREENE.

DISSECTING WITH PHONOGRAPH NEEDLES

ONE of the most useful and necessary adjuncts to the microscope is the dissecting needle, but by the very nature of their use, these delicate tools are subject to rapid deterioration. It is almost impossible to combat this condition by ordinary methods of cleaning and polishing. With a holder of the type illustrated and a packet of phonograph needles, one may always have a clean, sharp instrument to work with simply by withdrawing the old point and replacing it with a new one.

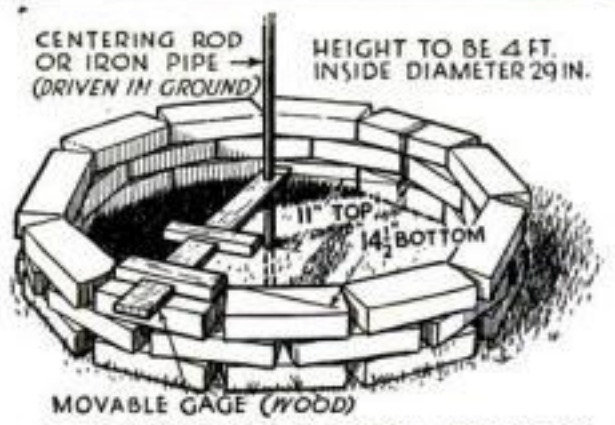


Sharp, slender phonograph needles form the renewable points of these dissecting tools for microscope work

The holders pictured were made of hard rubber ¼ in. in diameter and 4 in. long, though fiber, bakelite, or even a hardwood dowel rod would do as well. In the tapered end, a hole was drilled about ⅜ in. deep and of a diameter to make a snug fit for the shank of a standard phonograph needle. A few shallow grooves turned or filed at intervals about the shank of the holder not only give it a more finished appearance, but also afford a better grip for the fingers. Needles of the "half-tone" or "soft" variety, owing to their long, slender taper and fine, sharp points, are preferable to the common kind. Choose the type of point best suited to the work in hand.—R. G. BULLARD.

BRICKWORK INCINERATOR MADE WITHOUT MORTAR

A SAFE, inexpensive incinerator can be built in one hour from common brick laid radially without mortar as illustrated. The writer built one in his back yard that has been in service over a year and is good for many more, and it was not disturbed by the California earthquake last spring, which laid low other brick structures in the neighborhood. A recent test with a wood fire showed that although the bricks were heated to an incandescent temperature on the inside, one could hold his hand comfortably on the outside. This was due to the currents of cold air drawn



Brick incinerator laid without mortar, and the wooden gage used to insure uniformity

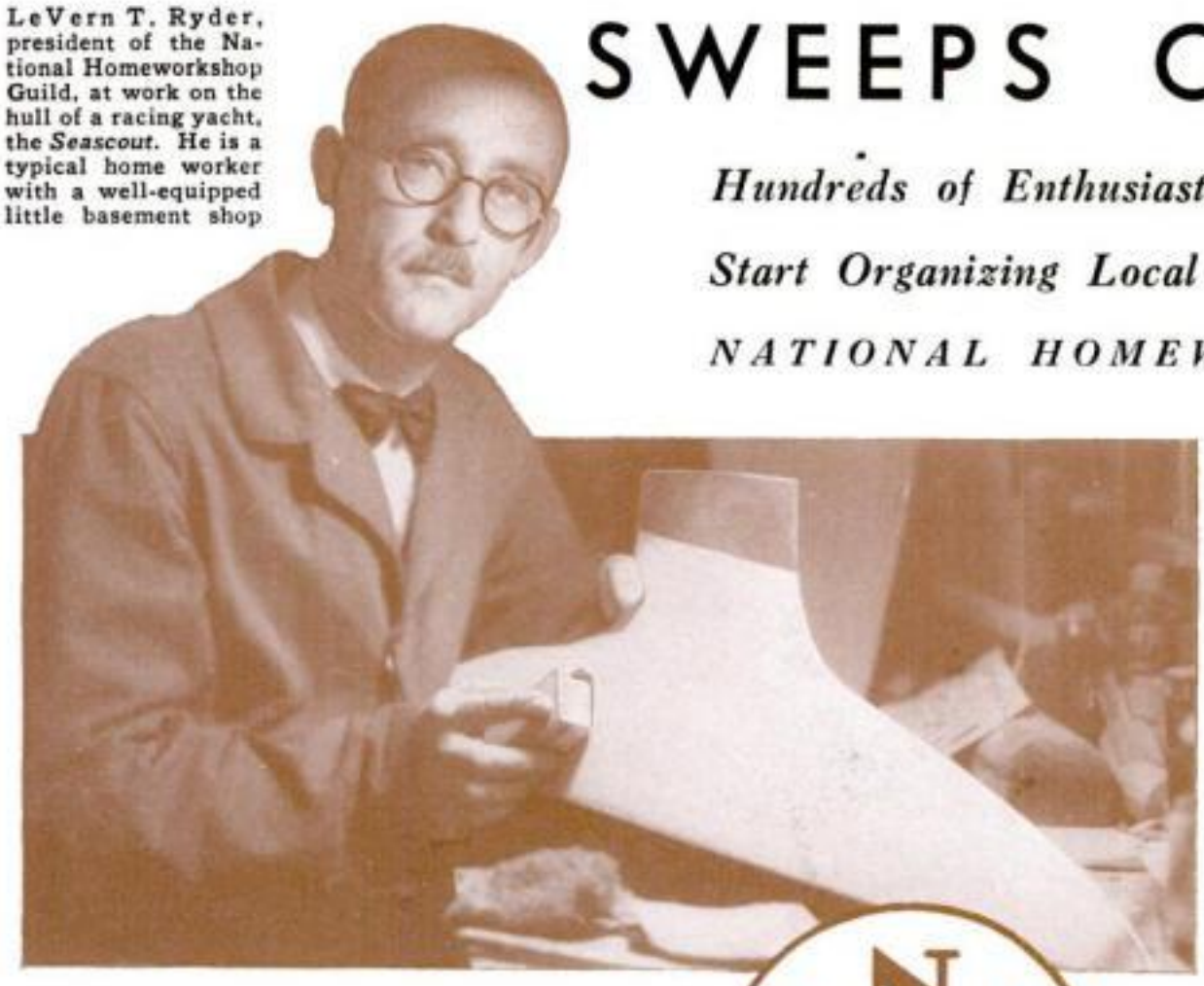
through the open joints from outside, displacing the hot gases from the fire.

Level off a space on the ground 4 ft. square. In the center of this, drive down a 4- or 5-ft. rod or length of pipe. Have this rod plumb and fairly rigid. Over this slip a gage made as shown in the sketch. Move it up the rod level with the course being laid.

Used brick are just as good as new if well cleaned. There are 19 rings of brick. In each of the lower 12 rings there are 11 bricks, but in the last 7 courses pull each ring in by shortening up the gage ½ in. for each ring. No clean-out is necessary as a few bricks may be removed at the bottom to take out the ashes. Do not plaster or seal up the joints with mortar. The outside may be kalsomined as the draft will prevent it from becoming smoked up.

A perforated piece of sheet metal or wire cloth reënforced with two rods and laid across the top is all that is necessary as a cover.—RALPH G. THOMAS.

HOME WORKSHOP CLUB IDEA SWEEPS COUNTRY!



LeVern T. Ryder, president of the National Homeworkshop Guild, at work on the hull of a racing yacht, the *Seascout*. He is a typical home worker with a well-equipped little basement shop

Hundreds of Enthusiastic Amateur Craftsmen Start Organizing Local Units under the New NATIONAL HOMEWORKSHOP GUILD

BY E. RAYMOND DELONG

Secretary
The National Homeworkshop Guild, Inc.

AS A HOME workshop fan, you have a personal interest in the new National Homeworkshop Guild. On my part, as the Guild secretary, I should like to show you the stacks of mail coming into our headquarters. The Guild idea has caught the fancy of the nation and opened up a new deal for amateur craftsmen.

The letters received have been of such an enthusiastic and encouraging nature that I wish several columns of them could be printed. One, for example, was from a large manufacturer in Indianapolis, Ind., who volunteered to provide a meeting room in his own plant for the first club to be organized in that city. Several other heads of large industrial plants have written that they are sponsoring the formation of clubs among their own employees.

A superintendent of schools in an eastern city has promised to make arrangements for any local club or clubs to use the shop facilities of his school system, which are among the best in the country, and he will also provide competent instructors. Manual training teachers have been particularly helpful. One says, "We have a craftsman's club started and would like an application blank for twenty members." A teacher of industrial education in a western teachers' college writes, "I am interested in forming a club as part of our industrial program in this community." An instructor in a large vocational school reports that he had a conversation with the director of his school, who is much interested, and continues: "If we can organize such a club, it will be possible to get a room for our meetings in the school, and if necessary the workmen can get help from our instructors in the various shops." Similar letters by the score could be quoted. Teachers in other departments, too, have written. One instructor in mathematics writes: "There is a small group of my friends who, I am sure, will be interested in your organization, and I am writing for them as well as myself. Your group should have the heartiest coöperation from all secondary schools, and I assure you that I will do all in my power to further the cause in this educational district."

Hundreds and hundreds of readers of POPULAR SCIENCE MONTHLY have been quick to see the advantages of organizing a local club and becoming affiliated with the Guild. *(Continued on page 71)*

ADVISORY COUNCIL

Professor Collins P. Bliss
Dean of the College of Engineering, New York University

Dr. Clyde A. Bowman
Dean of the School of Industrial Education, Stout Institute, Menomonie, Wisc.

Harvey Wiley Corbett
Architect, New York City

Dr. Hugh S. Cumming
Surgeon-General, United States Public Health Service

Maj.-Gen. Benj. D. Foulois
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Capt. E. Armitage McCann
Founder, Ship Model Maker's Club

Dr. Francis G. Pease
Astronomer, Mt. Wilson Observatory

Frank A. Vanderlip
Banker and Publicist, New York

FIRST ON THE HONOR ROLL

APPLICATIONS for charters, inquiries, and congratulatory messages have swamped the Guild headquarters in Rockford, Ill. We hoped to publish in this issue all charter applications now on hand. Because of the impossibility of completing the clerical work at the time we go to press, we are unable to do so. We are, however, listing the first seven clubs that have held organization meetings, sent applications to Rockford, had those applications approved and acted upon by the directors, and received back individual affiliate cards for each of their members. A list of their officers will appear later.

TOPEKA HOMEWORKSHOP CLUB
Topeka, Kansas
Twenty-two Members

DIXON HOMECRAFT CLUB
Dixon, Illinois
Ten Members

SILVERTON HOMEWORK CLUB
Silverton, Colorado
Ten Members

NAME NOT YET CHOSEN
Cody, Wyoming
Seven Members

AMARILLO HOMEWORKSHOP CLUB
Amarillo, Texas
Fourteen Members

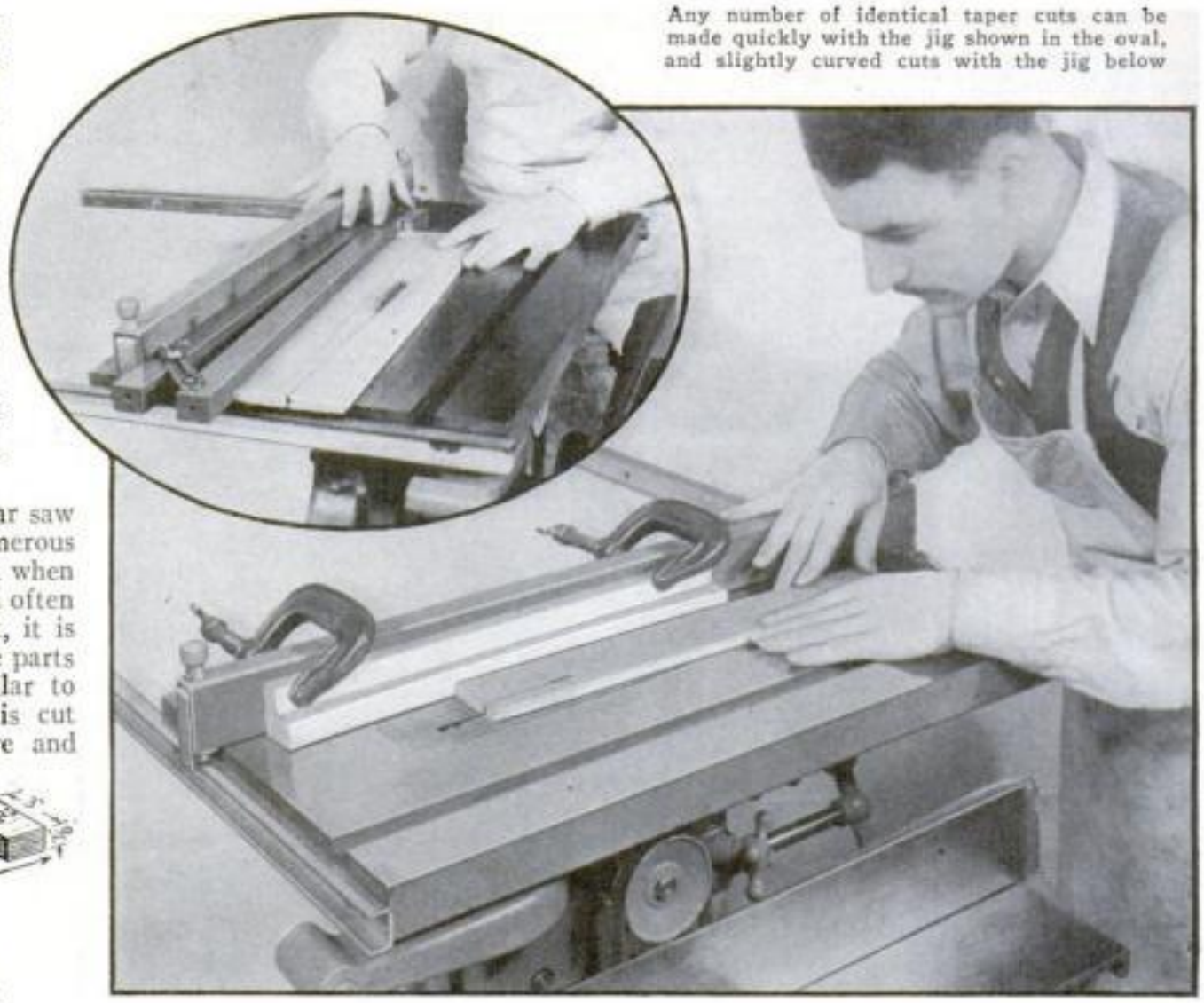
THE HILL TOP HOMEWORKSHOP CLUB
Cincinnati, Ohio
Six Members

FAIRFIELD HOBBY CLUB
Fairfield, Alabama
Six Members

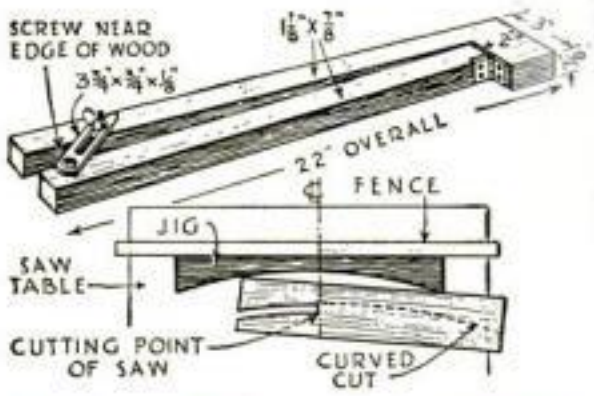
Jigs Simplify Cutting Tapers and Curves on a Circular Saw

ACCURATE taper cuts on the circular saw can be easily made by using the jig shown in smaller of the accompanying photographs and also in a perspective sketch below. This allows tapers from zero to 2 in. in 20 in. to be cut, or equivalent tapers in shorter or longer stock. The two legs are hinged together at one end and have an adjustment in the form of a slotted piece of strap iron at the other. A wing nut locks the movable leg at the desired angle. The control could be indexed, if desired, so that the taper could be set to any degree without measuring.

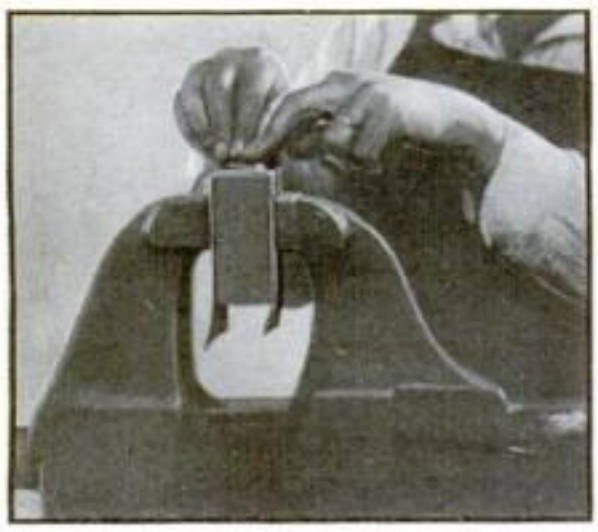
Extreme curves cut on the circular saw can be made only by running numerous cuts tangent to the desired line, but when the curve is slight or "slow," as it is often called, and the stock itself is light, it is possible to shape as many duplicate parts as are required by using a jig similar to the second one shown. The jig is cut out carefully to the desired curve and mounted on the saw table in such a way that it is held squarely against the fence and exactly central with the center of the saw blade. The saw must barely come through the wood, and it should be sharp and have a good set in order to insure success in production work of this kind. The jig does not move; it simply furnishes the two contact points for the work as it is pushed through. This is made clear in the lower of the two drawings at the left.—SAM BROWN.



Any number of identical taper cuts can be made quickly with the jig shown in the oval, and slightly curved cuts with the jig below



Adjustable jig for tapered cuts and diagram showing how slightly curving cuts are made



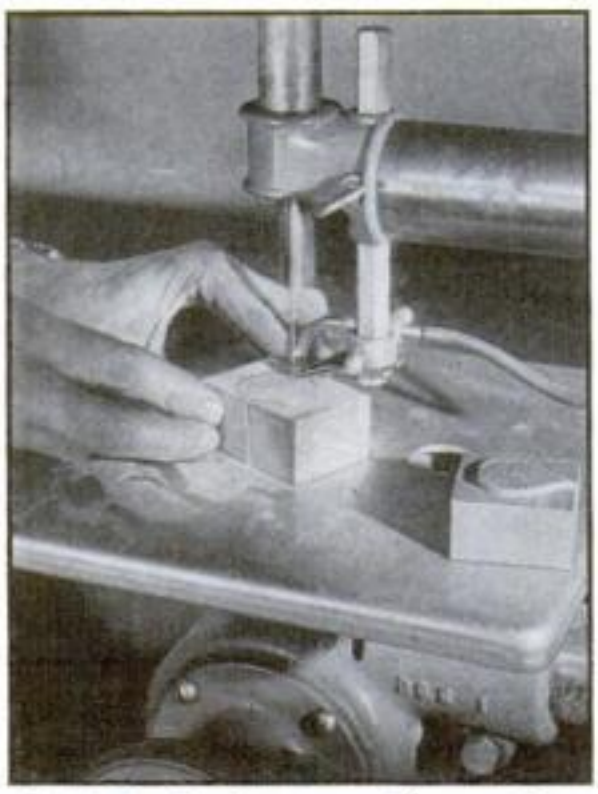
HOLDING SANDPAPER AND EMERY CLOTH IN VISE

THE usual plan of folding a sheet of emery or sandpaper around a block cannot conveniently be used where the piece to be smoothed is too small to be held in a vise or against a bench stop. It is much easier to hold the abrasive in the vise as shown above and move the work across it by hand. Fold the abrasive paper or cloth over a wood block as usual, clamp the combination in the vise, and then use two hammers to strike simultaneously upward against both ends of the block. The abrasive will cling to the vise jaws, and the block move upward within it until the emery or sandpaper is taut.—ELTON STERRETT.

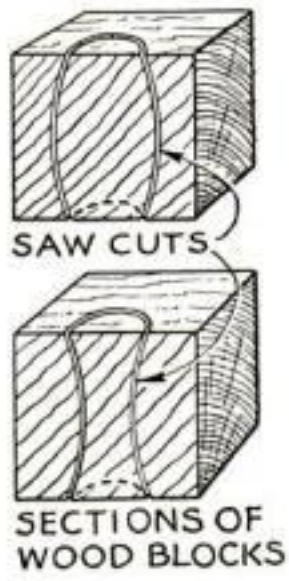
MYSTIFYING BLOCKS CUT ON JIG SAW

EVERY user of a spring-type jig saw who has tried to cut thick hardwood with an extremely fine blade has discovered that it is difficult, if not impossible, to make the blade travel in a straight up-and-down line. In a 1 in. thick piece of oak or other hardwood, the thin blade may bow out as much as ⅛ in. By taking advantage of this action, you can make a novelty that will baffle your friends. They will not be able to guess how you managed to make it.

Simply insert a fine jeweler's or jigsaw puzzle blade into your machine, and cut a circle or other shape in a thick block of hardwood. You can start the cut from one edge, or drill a small hole through which to insert the blade. The first arrangement will be found the better because the blade can be removed more easily after the cut. Usually the cut starts in a straight line and ends in a curved form, which makes completion a bit difficult. Operate the saw at slow speed. The plug will be shaped either like a barrel or a spool, and this effectively prevents its removal from the block. You may have to try several pieces of wood before you find one having the right hardness or grain structure to produce exactly the results that are desired. —ERVIN WALTERS.



Cutting the blocks on a scroll saw and, at right, how they would look if sliced in two



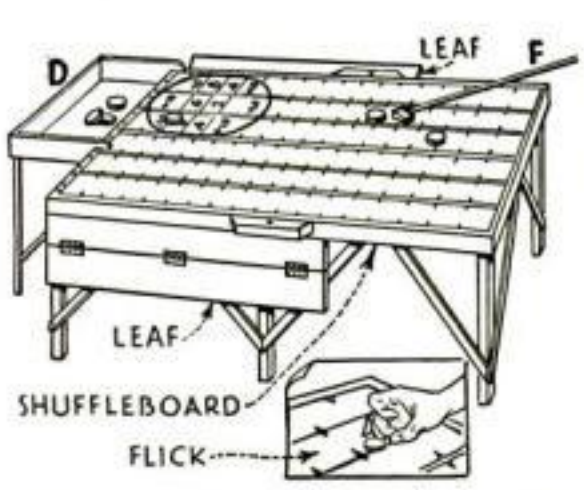
Seven-*in*-One Table

PROVIDES GAMES FOR ALL

By Frank H. Dunn

SEVEN different games can be played on this unique homemade table tennis or ping-pong table. It is a standard 5 by 9 ft. table to which a net can be fastened for table tennis, but there are additional lines and numbers inscribed on the surface, and various attachments and accessories are provided for the other games—baseball, bowling, shuffleboard, flick, bounce, and horse race.

To use the table as a miniature shuffleboard, the net is removed and the leaf on the east side (the sides being marked north, east, south, and west for ready reference) is hooked into active position to catch disks that slide off the side of the table. Then the tray marked *D*, which is 18 by 36 in., is placed at the north end to receive the overshots that would otherwise slide onto the floor. The east lengthwise half of the table is all that is required for the alley. On the north end of this east half is painted the usual shuffleboard diagram. Six 2-in. wooden disks painted red and six black ones are pushed from the line at the south end by means of the pushers *F*. These are 36 in. long. Alternating, each of the two players pushes a disk from the starting line into the diagram until all twelve disks have been disposed of. Tally is then computed by totaling those disks which are free and

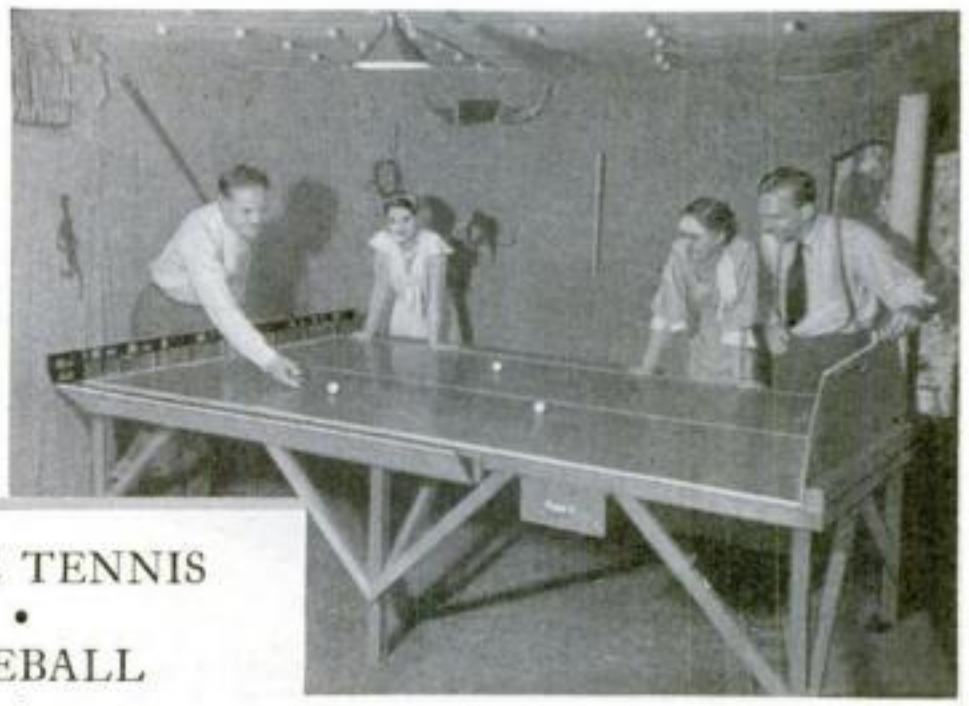


For both shuffleboard and flick, the east leaf is raised and accessory *D* is hooked on

clear of lines. The score is carried and compounded from inning to inning for as many innings as have been prearranged.

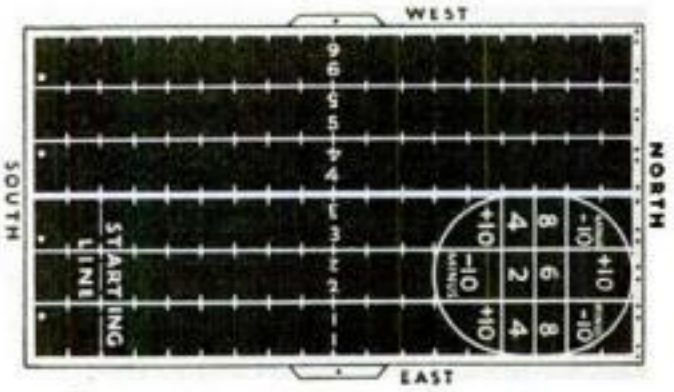
Flick is played under the same rules and in the same diagram except that checkers are used instead of disks. These are shot down the table by snapping the middle finger off the thumb. As many players may take part as there are different colored checkers; or, teaming up, each team member may use three checkers.

The third game is bounce. In that same tray *D* used in the two previous games is spread a piece of cloth folded to form several thicknesses. On this pad are placed two small hoops, and between the hoops two vases of different heights, one behind the other. The tin vases used by florists or the type of receptacles used to mix frosted *(Continued on page 73)*

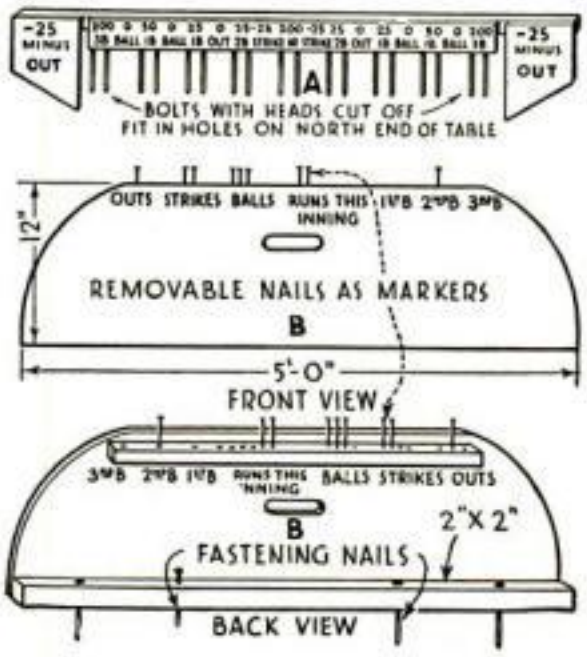


Playing baseball. The score for a nine-inning game rarely exceeds four or five runs because of the ingenious system followed

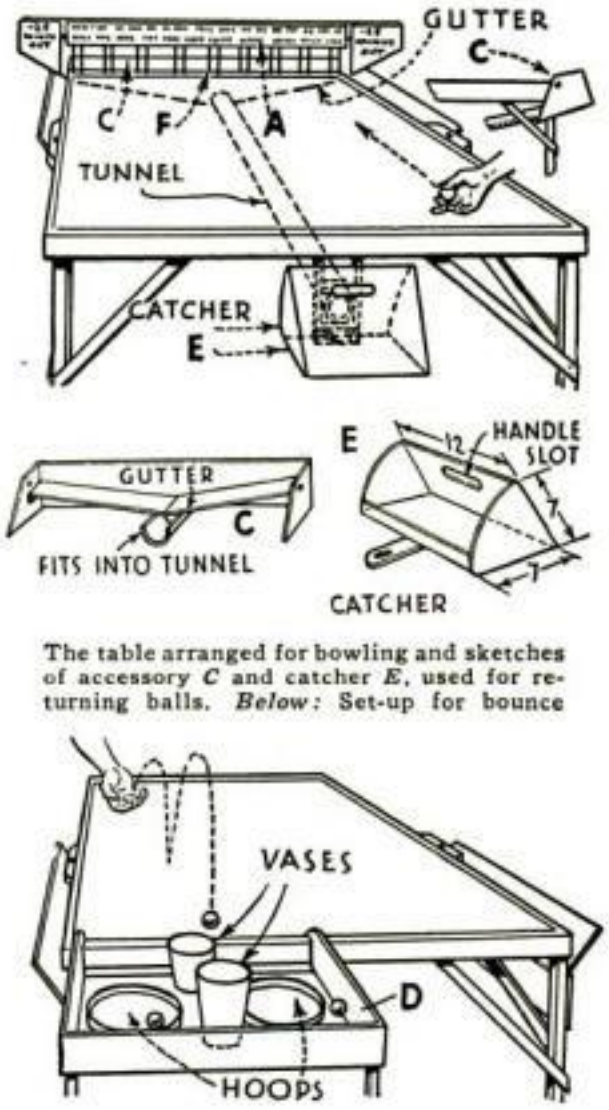
TABLE TENNIS
•
BASEBALL
•
BOWLING
•
SHUFFLEBOARD
•
FLICK
•
BOUNCE
•
HORSE RACE



The top painted for shuffleboard and horse race. The east half is used for shuffleboard



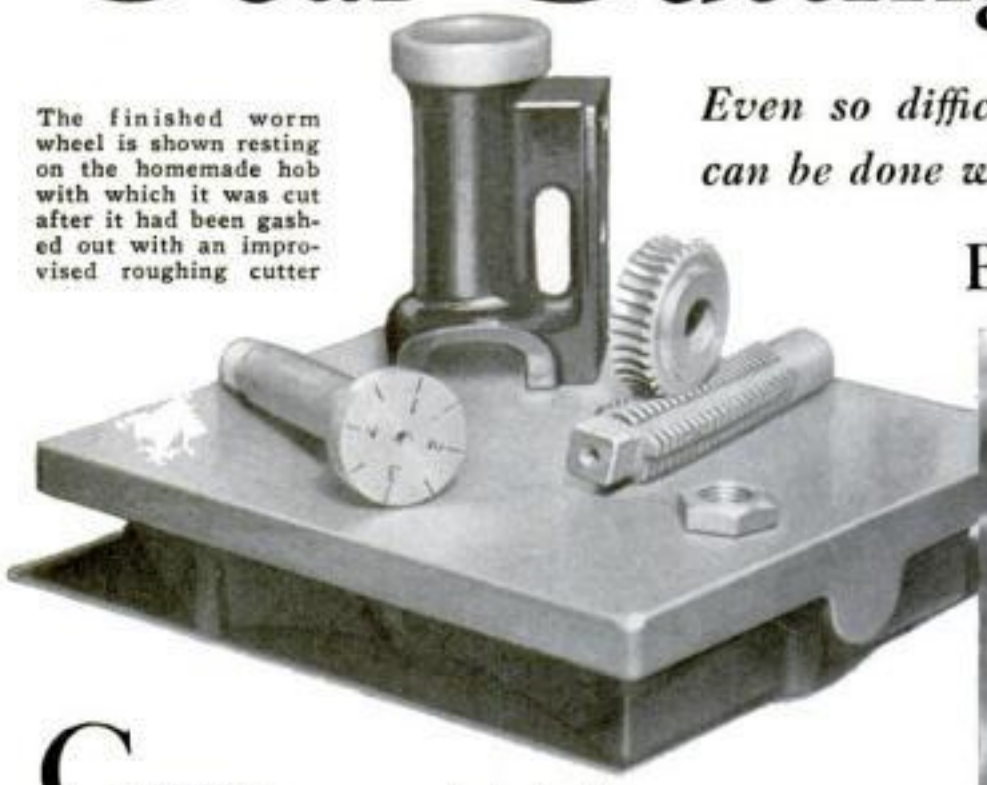
Accessory *A*, which is used for baseball and bowling; back and front views of accessory *B*; and the way they are placed for baseball



The table arranged for bowling and sketches of accessory *C* and catcher *E*, used for returning balls. *Below:* Set-up for bounce

BLUEPRINTS for Popular Science Monthly projects are listed on page 76.

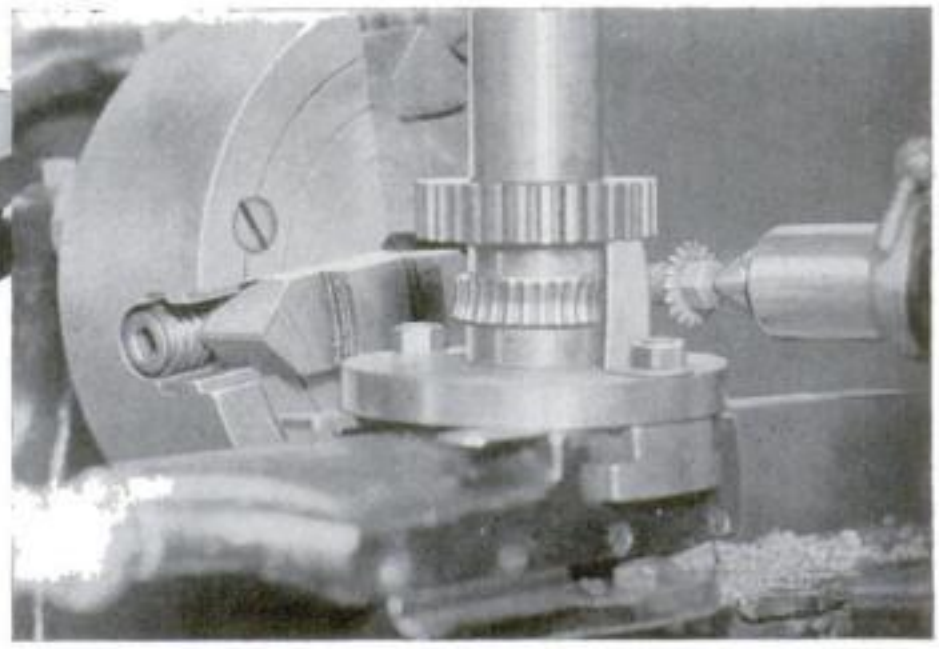
Gear Cutting *in the* Lathe



The finished worm wheel is shown resting on the homemade hob with which it was cut after it had been gashed out with an improvised roughing cutter

Even so difficult a job as hobbing a worm wheel can be done with limited home-workshop equipment

BY HOLT CONDON



The set-up for the roughing operation. One of the regular lathe change gears was mounted on the blank for indexing

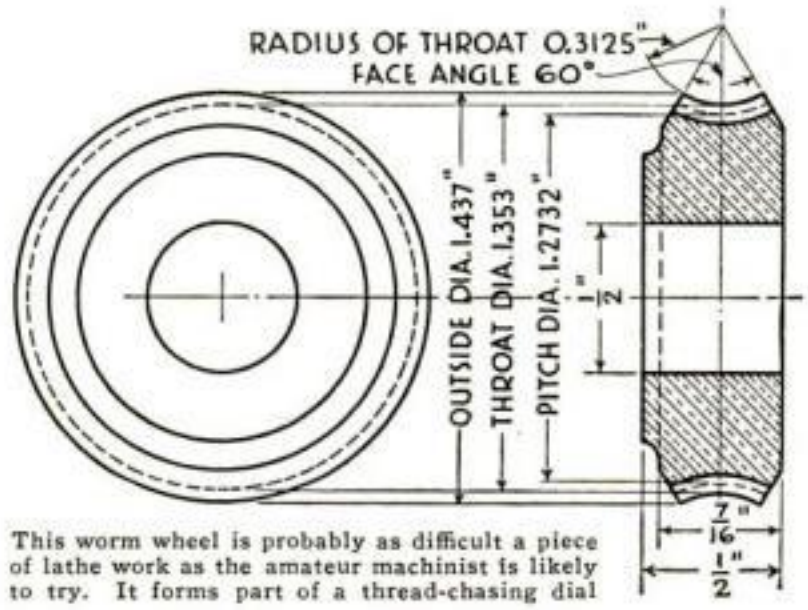
CUTTING a worm wheel by the hobbing process is rarely considered a job for the small engine lathe, but in the writer's home workshop, as in many other similar shops, such a machine is the only tool equipment. In this case the gear was needed to drive the thread-chasing dial described in a previous issue (P.S.M., Jan. '33 p. 71).

Special tools required were an improvised work arbor for mounting the gear blank, a gashing or stocking cutter to rough out the teeth, and a hob for finishing.

The hob photographed with the finished gear was turned from tool steel and threaded to correspond exactly to the lead screw of the lathe. This screw is ¾ in. in diameter. Acme form thread, 8 threads per inch. The squared shank and tapered end of the hob are not necessary features and were added only to make the tool usable later as a tap. A hexagon nut was soft-soldered on the tapered end and by this means the hob, while mounted on improvised centers, was indexed and wedged into position for cutting the flutes, which make of it a milling cutter. A 7/16-in. end mill mounted in the lathe spindle was used for this purpose. After fluting, the teeth were carefully burred and backed off with a file, and then the hob was hardened.

The roughing cutter was ground freehand from one of the hard-toothed disks used in dressing emery wheels. The cutter, which had been worn out in this service, was ground to ¾ in. in diameter, the teeth gashed deeper on a flexible wheel, and then ground to approximate form. This rough-and-ready milling cutter was then strung onto a ¼ by 3 in. cap screw with a section of ⅛-in. pipe for a sleeve and the screw head centerdrilled for the tailstock center.

A work arbor, required to mount the gear blank for cutting, was turned from a piece of 1¼-in. shaft, shoudered down to slip freely through the bore of the gear,



This worm wheel is probably as difficult a piece of lathe work as the amateur machinist is likely to try. It forms part of a thread-chasing dial

and threaded into a plate fitted to the lathe compound.

The gear blank was turned from a section of bronze rod and bored. Its throat diameter, the one critical dimension, was fixed by the desired number of teeth (32), and details of the lathe lead screw, that is, a single Acme screw ¾ in. in diameter and with a ⅛-in. lead or linear pitch. The dimensions given in the drawing were computed from a formula in a standard handbook on spiral and worm gearing.

The set-up for the roughing operation is shown directly above. For purposes of indexing the blank, one of the lathe change gears (32 teeth) was doweled to the blank and mounted just above it on the work arbor. A sheet-metal finger arranged to engage its teeth served to indicate positions, which were fixed after indexing by screwing the arbor down into the base plate. It will be noted that this plate is shimmed high on the chuck side, which inclines the arbor and blank to a degree corresponding to the thread angle of the screw. With this arrangement the gear was roughed out by sinking the cutter each time to the limit set by the cross-slide stop.

For the final hobbing operation, the roughed-out gear was allowed to turn freely on the arbor by drawing out the dowel pin, and then the arbor was brought into a vertical position. The hob, mounted on lathe centers, was now set in motion and the work fed into it, deriving motion from the generating hob. When sunk to the proper depth, as proved by the hob's just bottoming or "cleaning up" on the throat diameter of the worm wheel, the job was done.

GLASS CHECKERBOARD HAS GOOD PLAYING SURFACE

I HAVE played on several kinds of chessboards and checkerboards, and the best of them all is a board made of glass. To make one you will need a piece of window glass 13 in. square for a 12-in. board. I find this the best size for chessmen up to 3 in. tall. Take an old white show card or get a piece of similar cardboard from your printer and cut a piece 13 in. square. Rule off a margin of ½ in. all around, then divide the 12-in. square into 64 squares each 1½ in. Cut out 32 squares of the same size from heavy black paper and paste them on alternate squares of the board. Lay the glass on the cardboard and bind with 1-in. adhesive tape, or make a suitable frame from wooden molding. Chess tables can be built with this kind of glass board set directly and permanently into the top.—RAYMOND HOWARD.

Foot Bellows

SUPPLIES AIR BLAST FOR BRAZING AND HARD SOLDERING

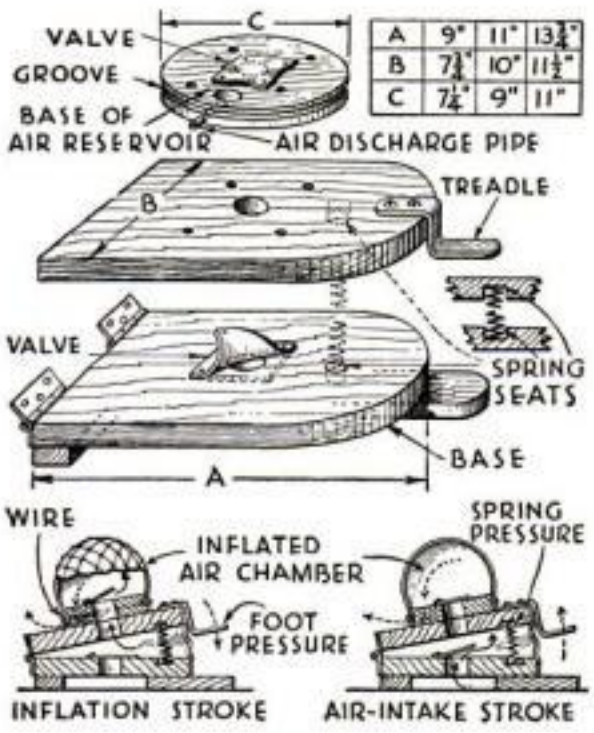
By J. S. Hagans

This inexpensive homemade foot bellows gives a steady supply of air for a blowpipe

AIR compressors and blowers operated by motors are comparatively expensive, therefore operations involving the use of an air blast, such as light brazing and silver soldering, are usually avoided in the home workshop. A foot bellows, however, meets the problem economically. The cost in no case should run more than two or three dollars, and of this the major part will be for the rubber diaphragm and net.

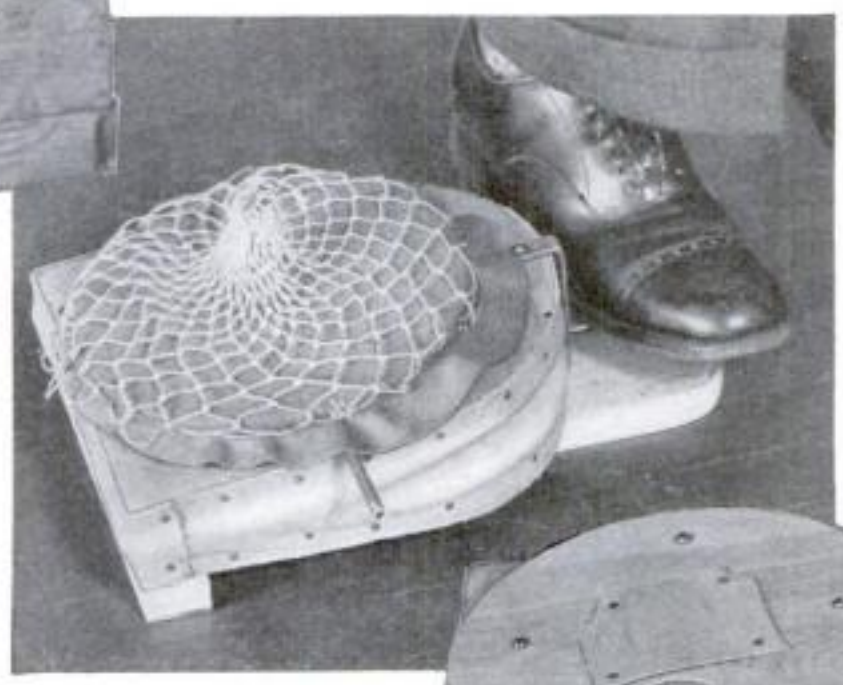
The drawing gives dimensions for three different sizes of foot bellows. It will probably be best to make the biggest one. The lumber used should be standard 1-in. stuff (13/16 in. thick when dressed). Slightly thicker stock is better for the circular air reservoir.

The air reservoir should be turned on the lathe. About ⅛ in. from the upper edge, a groove is turned that will be about 3/16 by 3/16 in. The reservoir is glued and screwed to the top board; then both boards are clamped together and a hole about 1½ or 2 in. in diameter is bored completely through all three with an expansive bit. If this is not available, a cluster of smaller holes will serve the same purpose. A square piece of leather is used for valves on the bottom board and the air reservoir, as shown. These valves are held in place by a carpet tack in each corner.



A	9"	11"	13¾"
B	7¾"	10"	11½"
C	7¼"	9"	11"

Drawings of the bellows with chart showing the dimensions for the three standard sizes



The bellows ready for use and, at right, how it looks before the rubber diaphragm and accompanying net are wired to the grooved edge of the wood disk

A short piece of spring will also be necessary for forcing the boards apart, and this is prevented from slipping by drilling holes part way through the boards into which the ends of the spring are inserted to hold it in place.

One or two hinges are set at the back, as shown. A cleat or batten is fastened across the back end of the bottom board, and a short piece is attached to the front.

The bellows leather can be either thin leather or any of the leather substitutes. Chamois skin, however, won't do—it leaks. It will be best to cut a paper pattern for this. The bottom edge will be straight, and the remainder will taper from the center to the ends. Carry the ends of the leather around the back, fastening it with glue and tacks. A strip of leather is used to make the hinge joint airtight.

The air outlet can be taken off at any point in the reservoir by drilling a large hole through it and then drilling a 3/16 in. hole into the first hole from the edge of the reservoir, underneath the groove. A piece of copper or brass tubing having an outside diameter of ¼ in. is threaded and screwed into the 3/16-in. hole.

The bellows is now ready for operation as soon as the diaphragm and net have been put in place. The three optional sizes correspond to diaphragms commercially available, and these as well as the nets may be obtained separately. It is best to find out what size diaphragms and nets are stocked by your dealer before starting the construction.

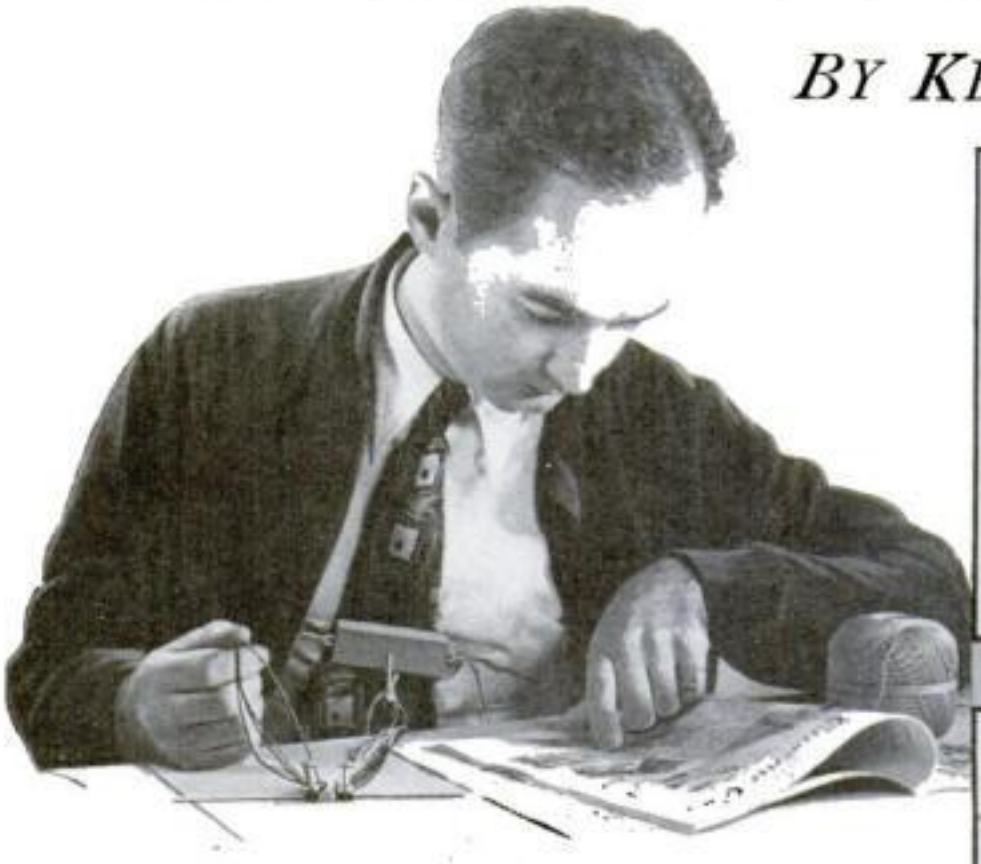
A piece of wire is threaded through the edge of the net; then the diaphragm is laid in place over the reservoir and held down below the groove. The wire is pulled up tightly, forcing the rubber disk into the groove, and given a twist or two to hold it. Installing a diaphragm is an awkward job that makes one wish for another pair of hands, but usually assistance can be obtained to get the edges tucked in under the wire. The purpose of the net is to prevent the diaphragm from being overinflated.

The action is such that air is stored in the reservoir and delivered to the mouth of the blowpipe in a steady flow so long as the pumping of the bellows is maintained. The principle of operation is illustrated by the small diagrams at the left.

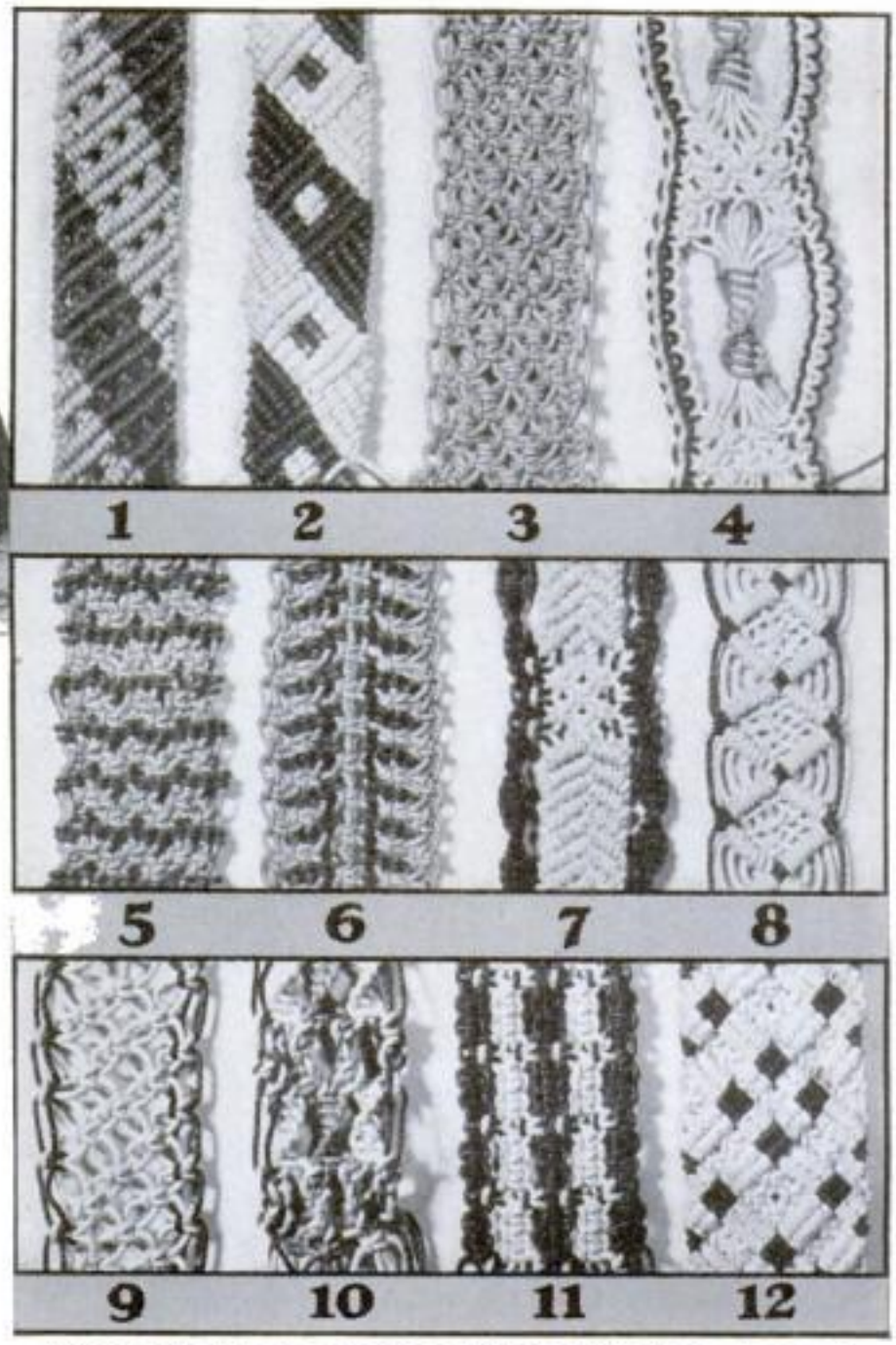
Twelve Novel Designs for

Knot-Work Belts

BY KENNETH MURRAY



Readers who have followed our previous square-knot articles can copy these new designs without difficulty by studying the photos



A dozen belt designs never before published. The first and second are of the wampum type; the others illustrate various combinations

ALTHOUGH square-knot work has been a popular handicraft with sailors since the time of Columbus, variety in designs for belts and other articles has been very limited. These new designs are presented in response to a demand from readers, and those who have followed previous articles in this series will find them easy to copy merely by studying the illustrations. Beginners in square-knot handicraft should first refer to the making of the knotted belt with which the series began (P. S. M., Nov. '32, p. 77).

The first suggestion is for what may be called a "wampum" belt design (see P. S. M., May '33, p. 63). It is made with three doubled dark cords and three of light. Start knotting in the upper left-hand corner by making a double half-hitch with the second over the first cord; with the fourth over the third, second and first, and so on. After every two rows make one row of knots facing at right angles to the others. The second is similar to No. 1 with reversal of the knots where necessary to follow out the design.

In the third design a solid color of cord is used for making the first row of square knots, while a single cord of another color is half-hitched across for another row. The alternating rows of square knots and half-hitches are continued.

For the fourth design, after making three rows of square knots, bring the sides to a point by omitting a knot on each side in each row. Make nine rows of square knots with the four cords on each side; then, with a doubled cord of contrasting color, make nine rows around the remaining cords in the center with the first half of a square knot, to form a spiral. Join the cords into solid square-knot work and continue.

Design No. 5 consists of solid square knots with every third row one of half-hitches made with another loose cord of contrasting color.

The attractive herringbone design marked No. 6 is similar to the fifth. The rows of half-hitches slant upwards and do not meet in the center.

In No. 7 four light cords, doubled, with two dark doubled cords on either side provide this design. After four rows of square knots, the dark cords are knotted, in spiral form, for fifteen knots. The white center cords are made into seven rows of half-hitches, as in the making of a wampum belt.

To make No. 8 the cords are arranged as in the preceding design; then one is carried from each side, diagonally, to the other side and covered with half-hitches tied with the center cords. The loose cords in the center are crisscrossed, under one and over one, while those coming down the sides are allowed to bulge outward slightly.

A belt that is elastic can be made with open-mesh knots as shown in the ninth design. Although the knots are tied tightly, considerable space is left between each.

By using the first half of the square knot for continuous knotting in spirals, the belt marked No. 10 is made very strong, although of openwork. Use eight doubled cords and spiral each set of four for seven knots; then spiral, for seven knots, only the three inner sets, allowing two outer cords on each side to be free.

The eleventh design is similar in construction to No. 10. Each four cords are square-knotted three times to make short, flat strips; they are then joined together for one row, and again separated into flat strips.

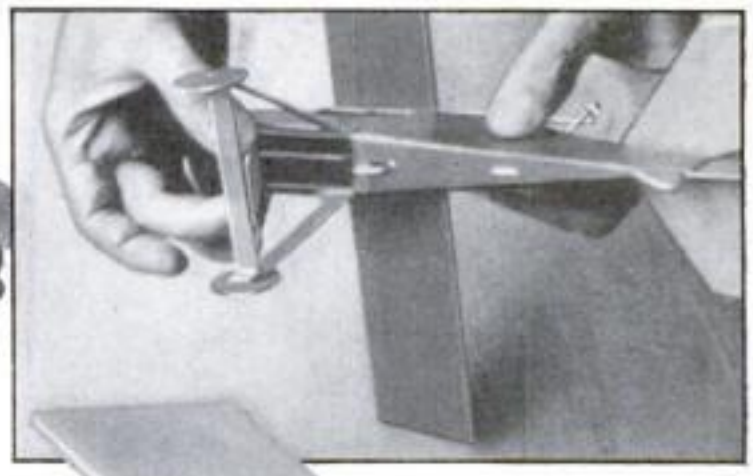
A combination of half-hitching and square knots is illustrated by No. 12. The outside cords are carried diagonally across the piece with two rows of half-hitches, the space between the latter being filled in with square knots. The design is obtained by reversing the order of tying the half-hitches, with the black filler cords becoming covering cords where desired.

Ticket-Dropping Airplane

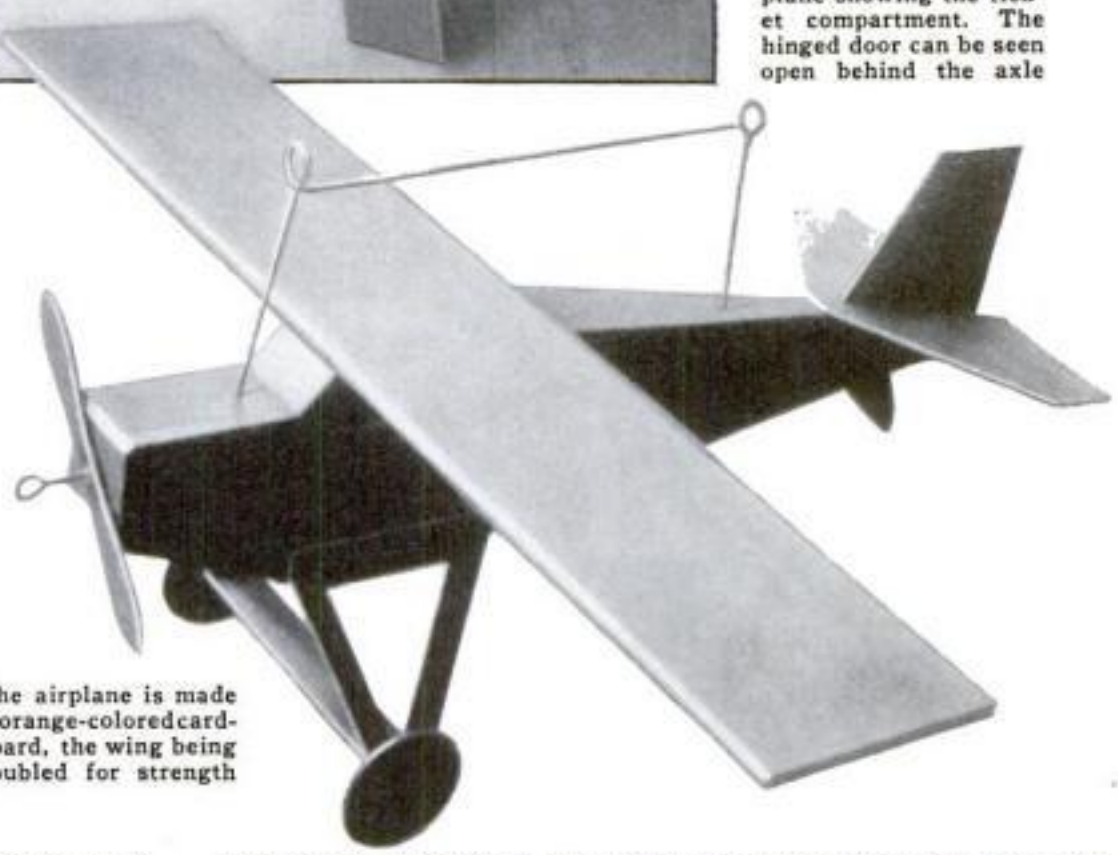
STARTS PARTY OFF WITH A BANG

By Donald W. Clark

The cardboard plane slides down a wire, hits the backstop, and dumps a load of tiny prize tickets



The underside of the plane showing the ticket compartment. The hinged door can be seen open behind the axle

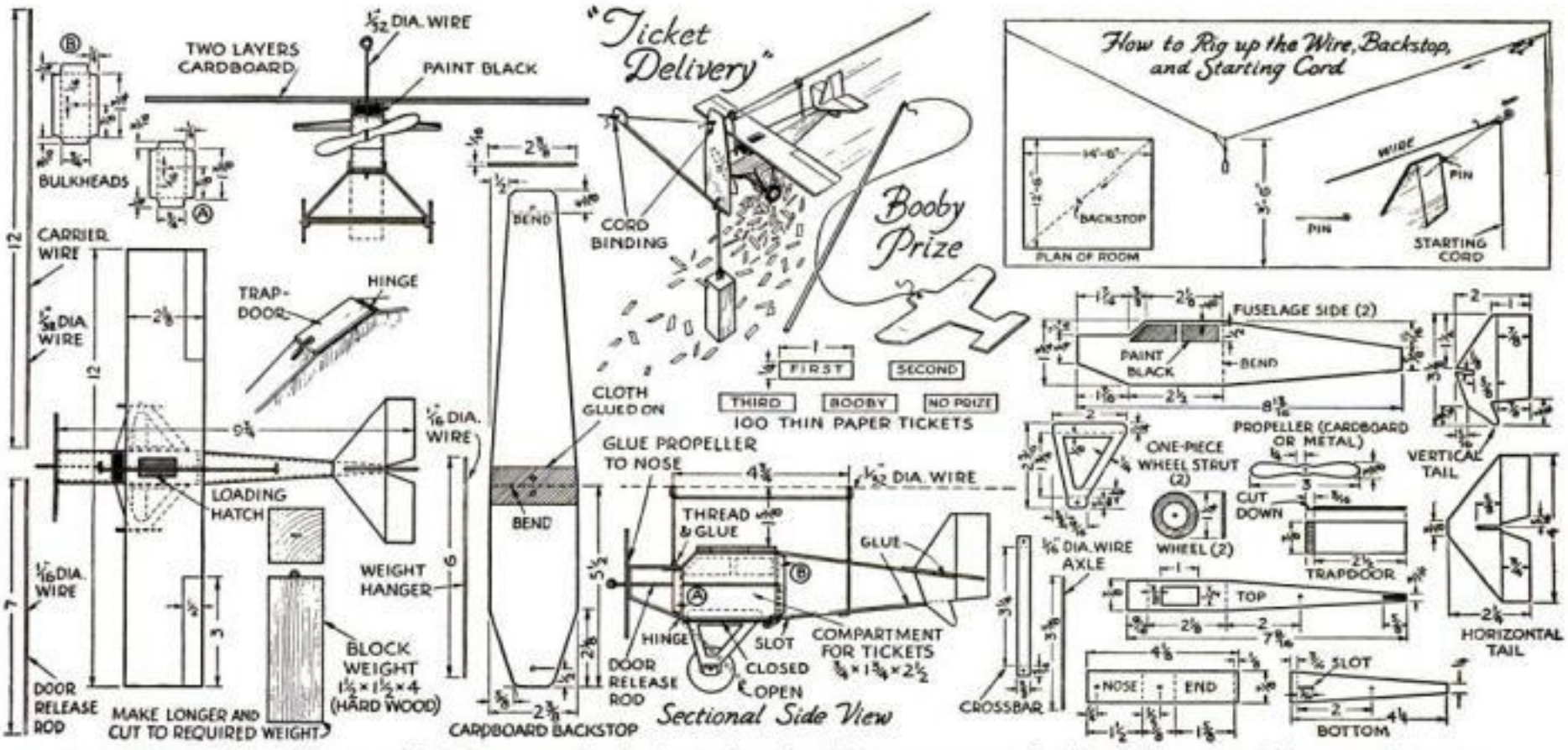


The airplane is made of orange-colored cardboard, the wing being doubled for strength

HERE is a novelty that will make a big hit at any gathering of young folks. All present except the host or hostess stand in a large circle. Any appropriate little airplane verse is recited, or a few introductory remarks are made about a ticket-dropping plane that is about to bring a load of good luck. Then the host or hostess jerks the starting cord, and a miniature plane slides rapidly down a wire and dumps a load of tickets in the midst of the guests, who scramble to pick them up. The resulting confusion and laughter will break the ice and start the party off in the right spirit of hilarity.

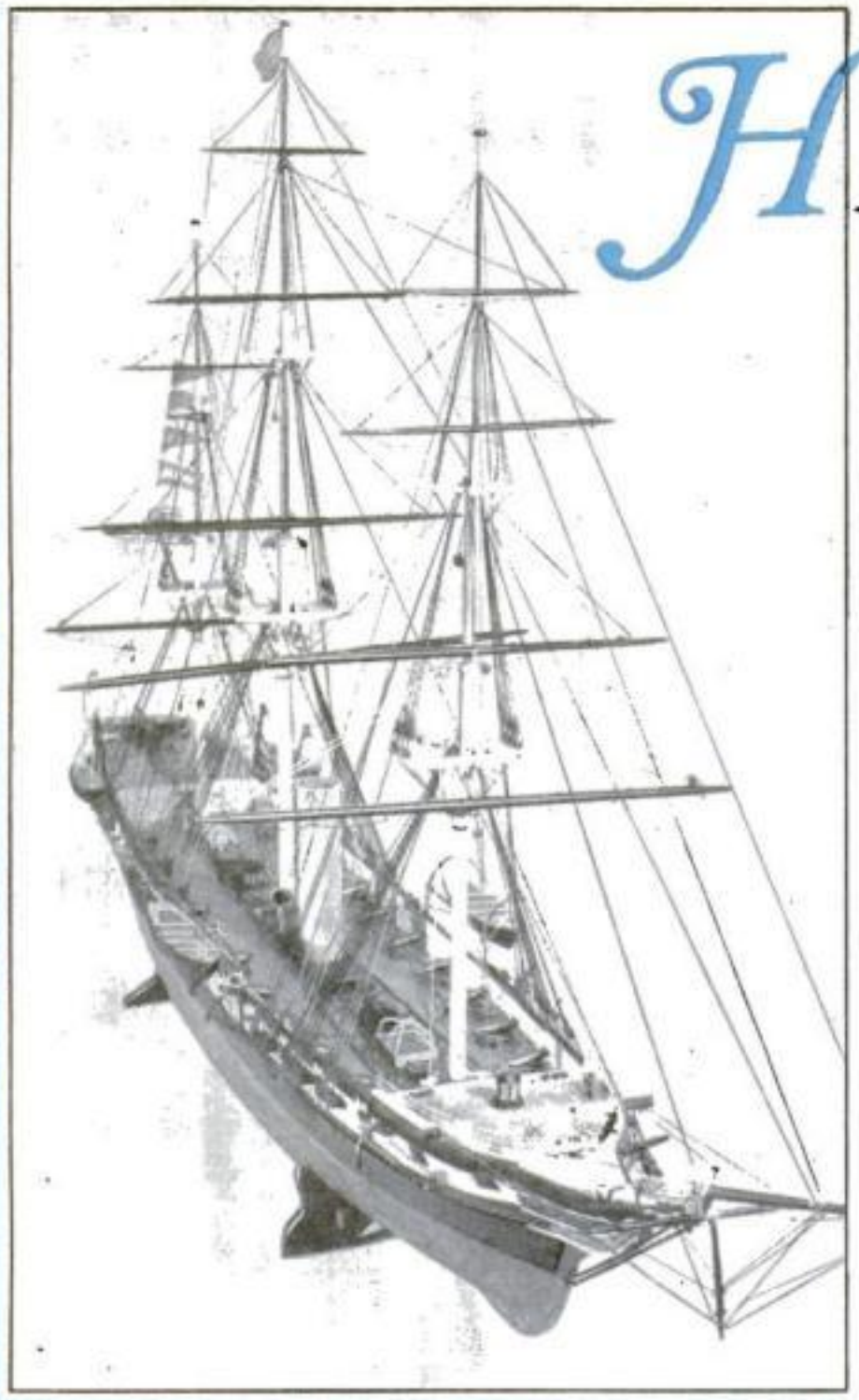
If twenty persons, for example, are present, 100 tickets are used, and each person is allowed to pick up five. Holders of the prize tickets are then lined up to receive their awards in order, and the big laugh comes when the person with the "booby" ticket is given a tiny airplane on a stick. Some slips are marked "no prize" to confuse the finders.

The airplane itself is made almost entirely of show-card board. All parts are glued together, and the wing is made of two layers. Construct the plane and rig up the wire, backstop, and starting cord as shown in the drawings. The plane should be loaded beforehand, and the backstop can be tied back out of the way with a string until it is actually needed.



Top and front views of the assembled plane, a sectional view to show the ticket compartment, details of all parts, and diagrams of the set-up

Finishing the Hull of Our HARTFORD Model



If you build this model of the *Hartford*, you will have an ornament of unusual distinction and value. It is 41 in. long, 25 in. high

ARE you building our new model of Farragut's flagship, the famous sloop-of-war *Hartford?* Of all the models I have designed for POPULAR SCIENCE MONTHLY, it is the one I should like to see the largest possible number of readers construct. That is because it is one of the most complete, interesting, and beautiful models imaginable. It seems to have everything to appeal to a ship model maker. I enjoyed every stage in making it, and I am sure you will, too, once you set to work.

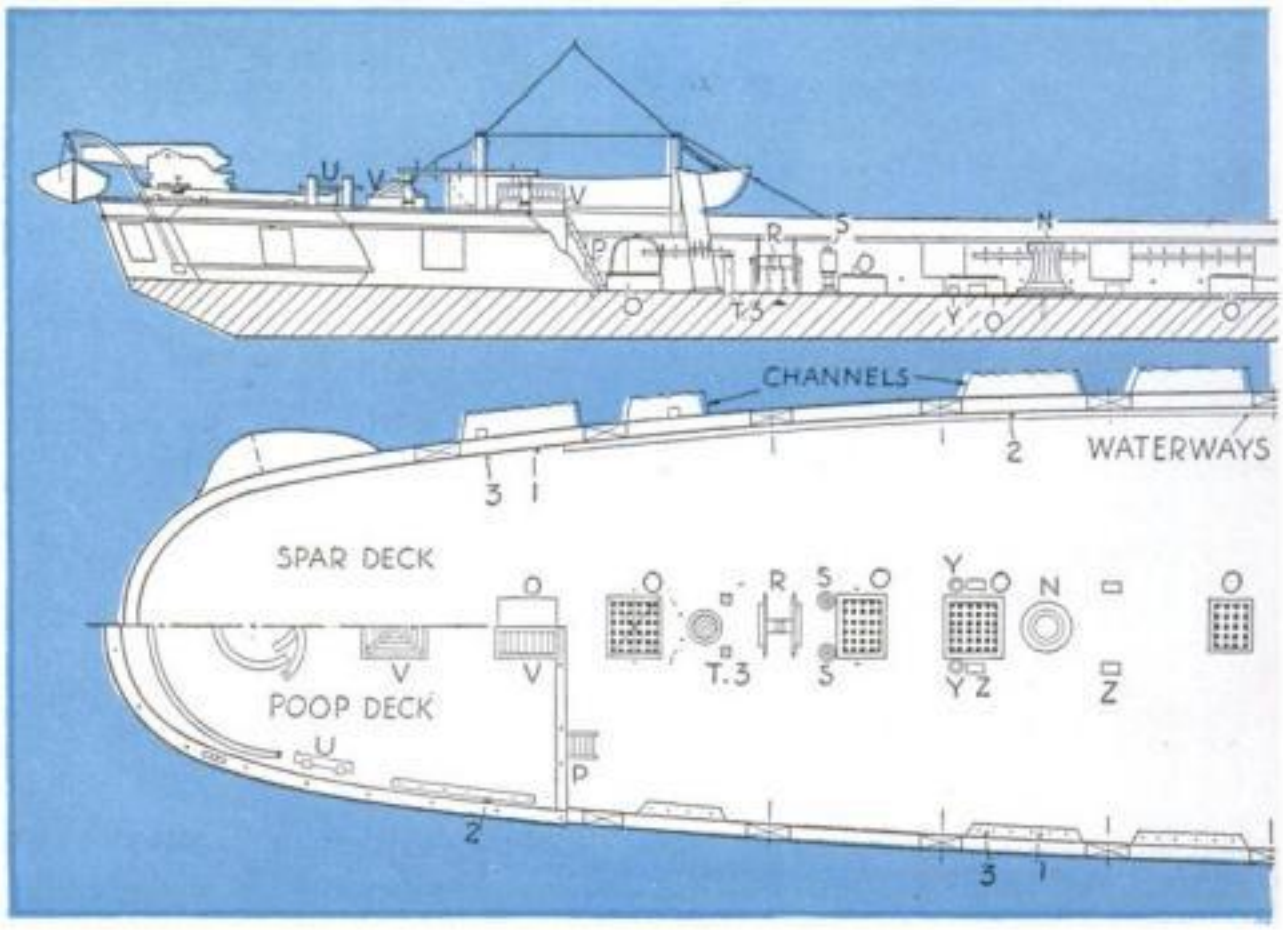
The construction of the hull was described last month (P.S.M., Jan. '34, p. 57). If you missed that issue, please look it up before continuing with the instructions in this article.

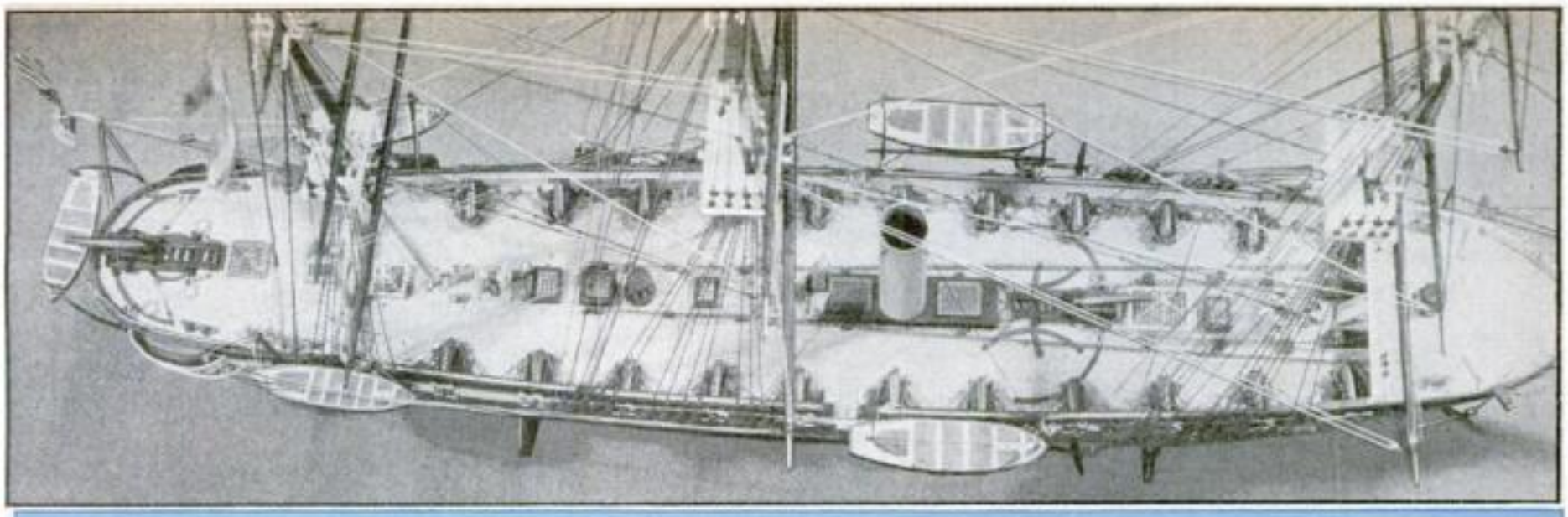
No one can read the history of the *Hartford* in the Civil War without the utmost admiration. What she accomplished was almost incredible. Under the command of Richard Wainwright and flying the flag of Admiral David G. Farragut, she was the leading ship of the Western Gulf blockading squadron in 1861. In January, 1862, this squadron reduced the defenses of New Orleans, Baton Rouge, and Natchez. In these engagements she had with her the screw sloops *Pensacola, Brooklyn,* and *Richmond,* the side-wheel steamer *Mississippi,* and nine screw corvettes. In April of that year she bombarded Fort Jackson for five days and nights and steamed up the Mississippi as far as Vicksburg, where she made junction with the Western Flotilla.

In 1863 she engaged the forts of Port Hudson, Grand Gulf, and other forts as far as the mouth of the Red River. The following year she blockaded and fought the battle of Mobile Bay and also took Forts Morgan, James, and Powell. At the end of that year, having been struck 240 times, she was ordered to New York and temporarily placed out of commission.

While this is stated here in a few brief words, it represents an unprecedented career of three years' hard fighting. It must be remembered that she had not only forts to contend with, but also the Confederate fleets of similar ships, ironclads, rams, fireboats, and other craft. In every engagement, however, Farragut's fleet obtained its objective.

To continue the building of this historic ship to the scale of ⅛ in. equals 1 ft., we still have some work to do on the hull. The next thing to make is the head with its trail board, deck, and so on. The cheek knees are solid pieces, cut to fit against the stem and along the beak. They should really come out beyond the trail boards, which are set into rabbets in the edges of the knees, but I found it easier and equally effective to follow





This deck view of the model will aid you in interpreting the drawings below. Because he was hard pressed for time, Captain McCann did not stop to hollow out the small boats, but he intends to do so and urges other builders to make them hollow. Details will be given later

By Captain E. Armitage McCann

the construction shown on page 86. The trail boards may need a little steaming to make them lie along the bow at the hawse pipes, and then along the beak with their curls just beyond it.

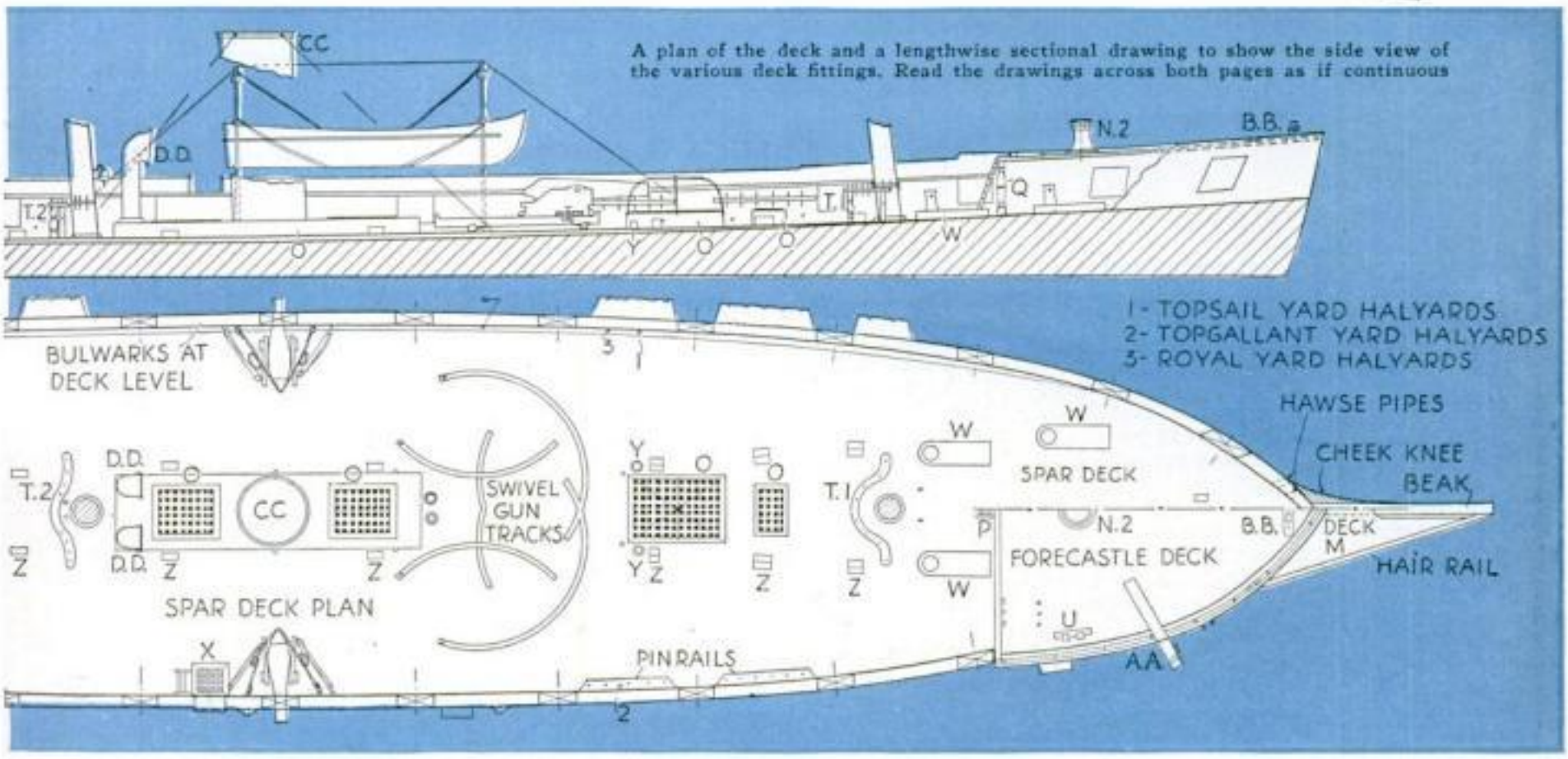
When making the stem, you may have cut the holes for the gammoning, but if not, this must be done now.

Instead of finishing the cheek knees at the top level of the trail boards, I carried them up as high again to make nailage for the filling-in pieces. Now, at about the deck level, fasten the hair rails from the bow to the end of the beak, where they pass back of the trail boards. Chamfer them as required. Inside of the hair rails and to the inside edges of the trail boards, fit 1/16 in. thick pieces to fill in the space between. About halfway up on these filling pieces may be run a thin molding.

It will now be necessary to make a short temporary bowsprit of the right diameter and bore for and fit it. The little beak deck *M* is fitted to lie on the filling pieces between the hair rails, so as to come close up to the bows. It has an oblong slot to allow the bowsprit to pass through. Note that the bowsprit is round but with a flattened top.

Next should be fitted the cap rails on the bulwarks. These should be only about 1/32 in. thick and extend about the same dimension beyond the bulwarks, inside and out. They run from end to end and are extended to the head and galleries with moldings. On these rails go the top rails or hammock troughs. These are in reality of very thin wood fastened to inside stanchions. I found it easier, in place of stanchions, to put solid blocks between the sides—one at each end, *(Continued on page 86)*

The holes for the masts are bored by using a block cut to the proper angle as a guide



A plan of the deck and a lengthwise sectional drawing to show the side view of the various deck fittings. Read the drawings across both pages as if continuous

Trick Photos

TAKEN WITH EASILY MADE ATTACHMENT FOR CAMERA

By Walter E. Burton

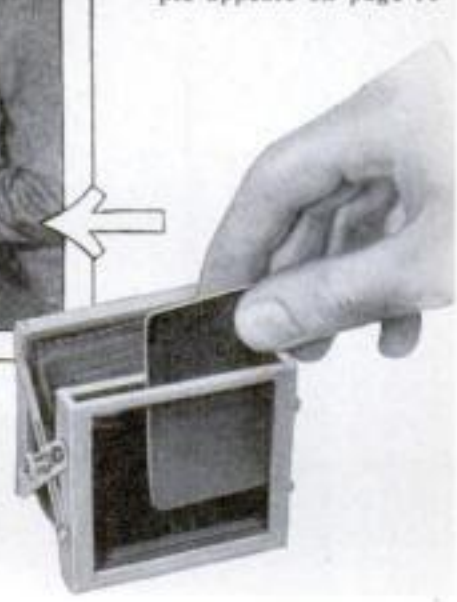
A "MAGIC BOX OF TRICKS" might be the name of this little attachment you can make for your camera. With it you can, among other things, take artistic photographs having various degrees of diffusion; produce negatives that have the central object sharply defined while the background and other details are softened and subdued; make vignetted portraits which gradually dissolve into blackness at the edges; take "reflection" pictures in which the principal object appears as if mirrored in the still water of a lake; produce duplicate pictures of the same person or object in different poses on the same negative, and make "ghost" photographs without resorting to the use of two negatives. In addition, the attachment serves as a lens hood that, by keeping out stray light, increases the sharpness of ordinary pictures. It also enables exposures to be made with the camera pointing into the sun. Finally, it acts as a holder for color filters.

In motion-picture work and among advanced amateur photographers, such a camera accessory is known as an "effect mat box." It is merely a boxlike hood for the lens, with a slot into which can be slipped various diffusing screens, filters, and the like. The device illustrated was designed so that it can be folded into a compact form and also can be adjusted with respect to the distance of the mats from the lens.

The size of the attachment will depend on the size of the lens with which it is to be used. That illustrated was made for a 12-centimeter (about 4¾-in.) lens on a 3¼ x 4¼ in. camera. The front opening measures 2¼ in. square on the inside, and the box unfolds to a maximum distance

A reflection picture taken with a mirror placed in the attachment as shown in the circle. Another example appears on page 70

A new kind of solitaire! This effect is obtained by using a duplicating card as shown at the right. The card prevents the exposure of half the picture



of 2¼ in., measured outside. The important thing to remember is that the front opening of the hood should not be so small or so far in front of the lens that it will interfere with the light cone.

The materials needed are a little ⅛-in. plywood such as that used for jig-saw puzzles, sheet brass for the attachment ring and side braces, some black satin or similar material, a number of common pins which, reduced in length, make excellent nails; several small radio bolts, and a small amount of shellac in which some lampblack or drop black has been mixed.

In a square piece of the plywood, cut a circular opening the size of the lens barrel. Around the edges of this piece fasten a frame of plywood strips about ¼ in. wide. Over the opening mount the attachment ring. This is made from strip brass, with three lugs bent at right angles and drilled as shown. The ends of the strip are bent and drilled to receive one of the

Snapshots at Night!

. . . with Eastman's remarkable new "SS" film

NOW the camera joins the family circle indoors. Old picture-making rules are forgotten. You can take snapshots in the house—at *night!*

All you need is a camera with an *f*.6.3 (or faster) lens, two or three Mazda Photoflood Bulbs that screw into any socket, and Kodak Super Sensitive Panchromatic Film—Kodak "SS" for short. It has three times the speed of ordinary film under artificial light.

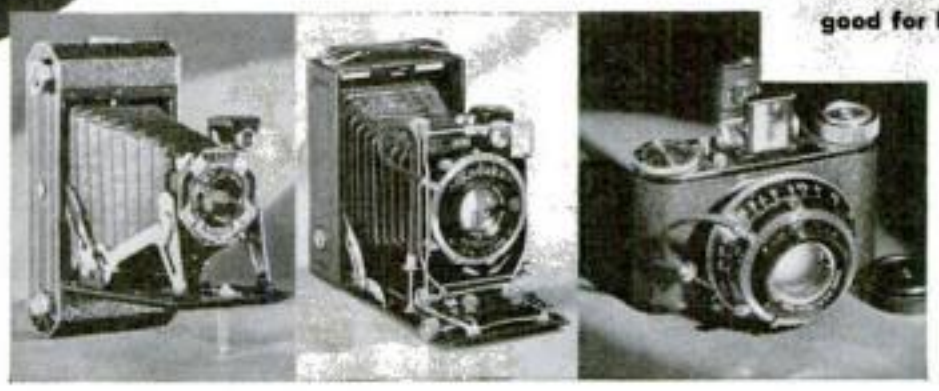
Hold the camera in your hands as you would outdoors. One click of the shutter and you've made a snapshot —at NIGHT!

KODAK "SS"—the lightning-fast film, with green lightning flashes on the familiar yellow box.

KODAFLECTOR—Inexpensive, efficient... makes 2 Photoflood bulbs do the work of 9. Complete, with stand, reflectors and cord, $5.

FINE CAMERAS . . .
Ideal for Night Snapshots

KODAK SIX-20 (below at left), *f*.6.3 lens, ideal for night snapshots, 2¼ x 3¼ pictures. $17.50. **KODAK SIX-16**, *f*.6.3 lens, 2½ x 4¼ pictures. $20. **RECOMAR 18** (center) . . . a versatile camera. Ground glass back, self-timer, double-extension bellows, 1/250 Compur shutter, *f*.4.5 lens—$46. **PUPILLE** (right) . . . Miniature camera. Ultra-fast *f*.2 lens . . . speeds up to 1/500. 16 pictures each loading. With case, range finder, two filters—$90.



● Arrangement of lights: Two Mazda Photofloods (35¢ each) in lamp "A"; one Photoflood in lamp "B." Photofloods (illustrated at left) are good for two hours or more of continuous use . . . good for lots of pictures.

INTERESTING FREE FOLDER. Indoor pictures are easy with "SS" Film—the only trick is arranging your lights. Ask your dealer (or write us direct) for the new, free folder, "Snapshots at Night." This leaflet also tells how to make successful night pictures with any camera with the 15¢ Mazda Photoflash lamp. Eastman Kodak Company, Rochester, New York.

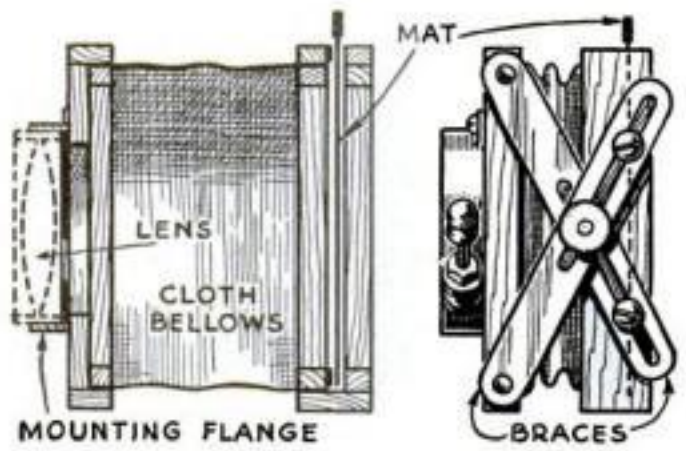
The effect-mat box is attached to the camera by a lens-barrel clamp made as shown at right. One of the nuts is soldered to the bolt, the other to the ring

Inserting a diffusing screen into the slot of the mat box for a soft-focus portrait such as professional photographers take

Two stunts in one. Looked at this way, it is an unusual reflection picture. Turn it upside down, and the reflection gives the illusion of terrific speed

bolts, and a nut is soldered over one of the holes. A short distance from the end of the bolt, solder a second nut so that, when the bolt is passed through the holes and screwed into the nut attached to the strip, the ends will be drawn together.

The front portion of the box consists of a square frame of plywood with strips glued to the inside to form grooves about 3/16 in. wide along the vertical and lower horizontal members. The upper horizontal part of the box has a slot formed by two strips running parallel.



A section through the box to show the construction, and an outside view with the bellows partly folded

Two pairs of slotted brass strips, mounted as shown, serve as supports for the front. They are locked in position by small bolts that pass through the slots at the crossing point. Knurled battery binding post nuts and lock washers are used with these bolts so that it will be easy to tighten them.

The bellows is made of a double thickness of satin attached to the front and rear wood pieces by means of glue and wood strips. The same strips that help form the grooves in the front piece also serve as clamps for the cloth. Paint the inside of the wood parts with the shellac-lampblack mixture, which produces a non-reflecting, dead-black finish. You can lacquer the outside or finish it in any other manner desired.

There are numerous forms the mats can take. You may find it more convenient to make them up as needed, to produce whatever effects are desired. For softening or diffusing the picture, fine-mesh screen wire, such as that used for bolting flour, is suitable. It can have either a black or a metallic finish, although black seems to be more favored. Cut the wire to slip into the slot and project for a fraction of an inch above, so that it can be grasped for removal. Bind the edges with lantern-slide or *passe partout* tape. Different degrees of fineness may be used to obtain various amounts of diffusion, or one or more pieces of the same mesh can be combined. By cutting circular holes in the center of the portion included by the box, you can keep some of the picture sharp while the rest is diffused. Instead of wire, you can employ mosquito netting, thin silk stocking material, and the like, stretched taut. With any type of diffusing screen it is necessary to increase the exposure in proportion to the density of the material.

A vignette mat that darkens the edges of the picture is made by cutting a jagged circular or rectangular hole in a piece of black cardboard. Experimenting will reveal the best size and form for given results. Normal exposure is sufficient.

In making pictorial landscape photographs and the like, it sometimes is desirable to have the corners and edges, particularly the upper ones, slighly darkened. This can be accomplished by the use of a special vignette mat. You can probably devise a mat that will take the place of a filter by holding back some of the light from brilliant skies, permitting the landscape proper to register without hopeless overexposure of the sky.

For making duplicate exposures, simply

"Night" picture taken at noon through a red filter on an infrared sensitive plate. *At right:* A vignette mask

insert a piece of black cardboard that covers about two thirds of the opening, leaving uncovered a vertical strip along one side. The mat box can be folded back close to the lens when this is done. For a double picture, place the object so that its image falls on one half of the film, and arrange the cardboard piece so that the portion of the lens nearest the object is uncovered. Make the exposure, allowing three or four times the usual time for the lens stop used. Move the cardboard to the other side of the *(Continued on page 71)*

TAKING TRICK PHOTOS

(Continued from page 70)

frame, arrange the object so that it will be registered by the remaining, unexposed half of the film, and make another exposure of the same length. Avoid backgrounds that will move during intervals between exposures.

For artificial reflection pictures, mount a small piece of mirror by means of pins or notches cut in the wood so that its surface is parallel to the bed of the camera and its rear upper edge at the center of the lens. Insert a rectangular piece of black cardboard in the bottom of the effect-box slot to cover the lower portion of the lens. The mirror also can be placed lower to produce slightly different effects. If the camera is of the focusing type with a ground glass, you will have little trouble in adjusting the mirror. The exposure is not affected by the mirror.

With the effect mat box you can use all kinds of inexpensive filters made by mounting filter gelatin in cardboard frames that will fit the slot. Such gelatin can be purchased for about ten cents a square inch. It should not be touched by the fingers or spotted with moisture. If handled with these precautions, it will last a long time. You can, by making your own filters in this manner, build up at small outlay a collection that will enable you to do many tricks when employing color-sensitive films or plates, including the new infrared sensitive plates recently introduced.

When used without any mats or filters, the box still is a valuable camera accessory. Many pictures can be improved by use of a shade over the lens because it excludes stray light. This results in a more brilliant image. And, as already mentioned, the shade enables the taking of against-the-light pictures, which often are more attractive than any other kind.

HOMEWORKSHOP GUILD

(Continued from page 59)

This is being written exactly three weeks after the first announcement, and I have so far taken care that full information about the Guild has been sent promptly to everyone who wrote in. You can have this same information, together with our lengthy Bulletin No. 1 on forming a home workshop club, merely by filling out the coupon below.

Every member of a local club receives an individual affiliate card in the National Homeworkshop Guild. The club at Rockford, Ill., holds Charter No. 1. Charters are being issued to other clubs in the order in which their applications are received. In the years to come, a very low charter number will be a badge of honor among the affiliated clubs. POPULAR SCIENCE MONTHLY, as the official magazine of the Guild, will report the organization of each club and list its officers.

National Homeworkshop Guild
c/o Popular Science Monthly
381 Fourth Avenue, New York, N. Y.

I am interested in the home workshop club idea and wish to know what the National Homeworkshop Guild will do for me. Please send me this information in the large self-addressed and stamped envelope I am inclosing.

Name .....

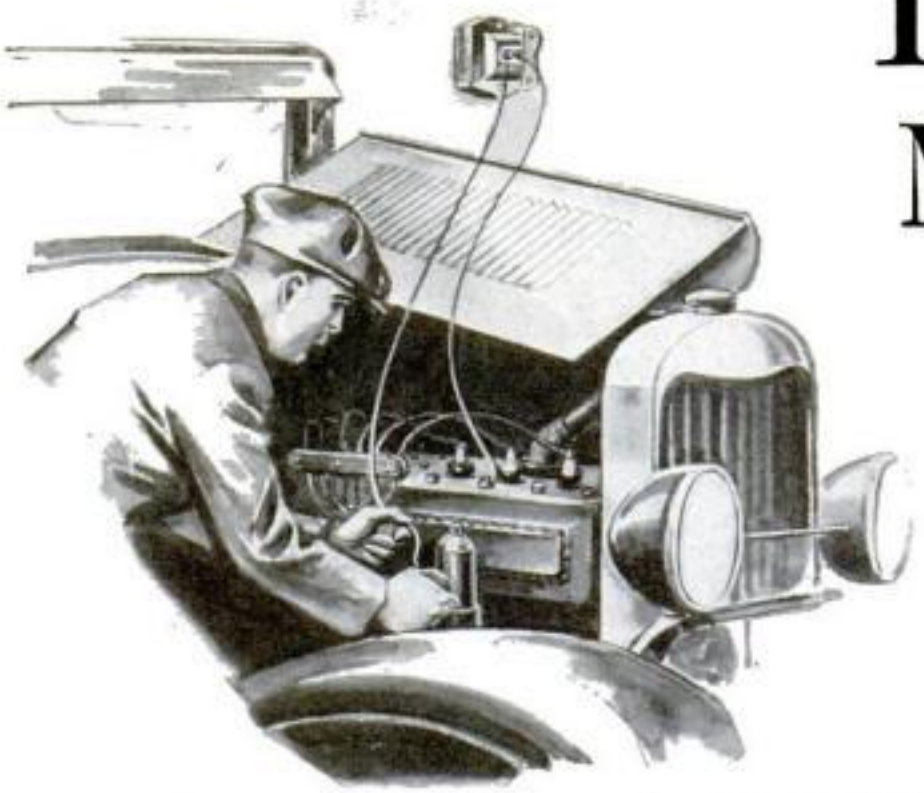
Address .....

City..... State.....

(Please print very clearly)

Tricks to Help MOTORISTS

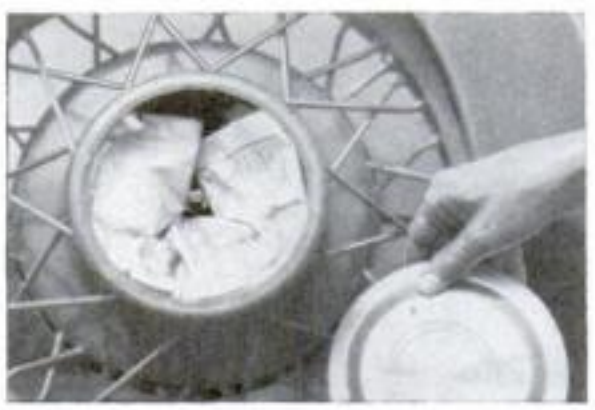
Valuable Suggestions for Drivers Contributed by Experienced Readers



Transformer, supplying the bell system in residence, was wired to car's ignition coil and used to start the car when battery failed

Bell Transformer Starts Car With Dead Battery

ONE morning recently when I was in a hurry to get the car started, I came to the sad realization that my battery was dead. Spinning it by hand failed to stir up even a sputter. In trying to think of some way out, I spied the six-volt transformer that supplied the bell system in the house (my garage is built into the house). With the car ignition switch *off*, I connected two wires to the six-volt side of the transformer, wired one lead to the wire that usually supplies the battery current to the ignition coil, and grounded the other to the motor. When I spun the motor this time, it started easily. Then, acting quickly, I switched on the car's ignition and at the same time yanked the two transformer wires free of their moorings on the motor. Unfortunately, this system will not work on cars fitted with protected distributer cables.—J. J. A.

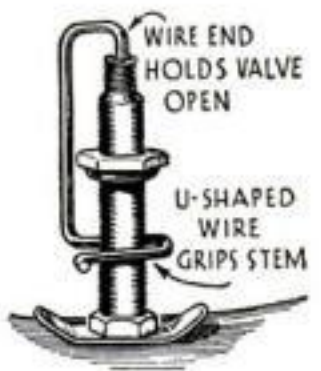


Storing Towel and Soap

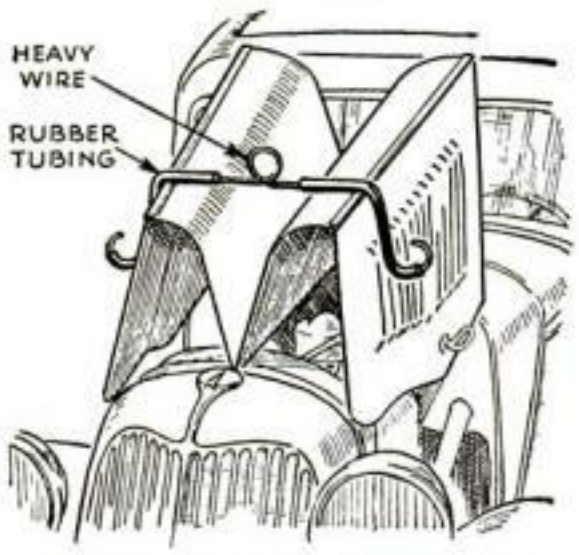
EVEN under the best conditions, changing a tire is a messy job. But it always seems worse when you are on the road and have no towel and soap for the cleaning-up process. However if your car has large hubs, there is no excuse for not carrying a towel and soap with you. The space under the hub cap of your spare tire provides room for several towels. Wrap them in paper, stuff the package inside the hub, snap the disk cap back into place, and they will be there when you want them to clean up after a dirty job on the road.—R. M.

To Deflate Inner Tube

AFTER testing an inner tube for leaks, you are confronted with the problem of deflating it. Of course, you can let the air out by holding down the pin with the valve cap but that takes time and keeps you from your work. The easiest solution to the problem is to make the simple tire deflater shown in the drawing. It consists of a piece of stiff, springy wire bent to form two U-shaped loops—one horizontal and one vertical. The wire at the end of the vertical loop is inserted in the top of the valve to push down the pin while the horizontal loop holds the wire in place. —M. Y.



Drawing shows how to make wire device that depresses pin in valve stem and so releases air

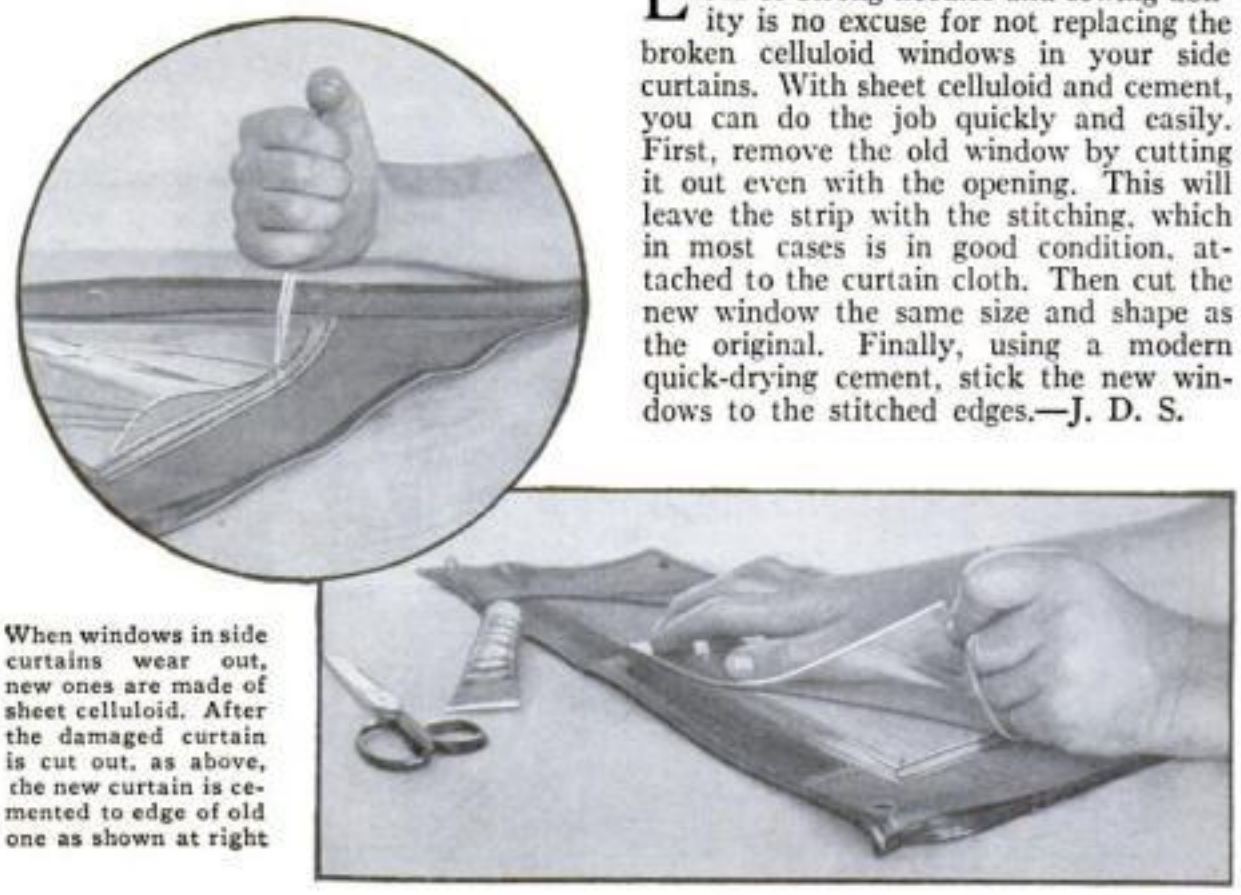


Wire Holder for Hood

OFTEN when working on a car motor, it is convenient to have both sides of the hood open at the same time. The wire hood holder shown makes this possible. The holder can be made from any scrap of sturdy wire. To protect the finish on the sides of the hood, slip short lengths of small rubber tubing on each of the legs.—M. A.

Replacing Celluloid Windows in Side Curtains

LACK of strong needles and sewing ability is no excuse for not replacing the broken celluloid windows in your side curtains. With sheet celluloid and cement, you can do the job quickly and easily. First, remove the old window by cutting it out even with the opening. This will leave the strip with the stitching, which in most cases is in good condition, attached to the curtain cloth. Then cut the new window the same size and shape as the original. Finally, using a modern quick-drying cement, stick the new windows to the stitched edges.—J. D. S.



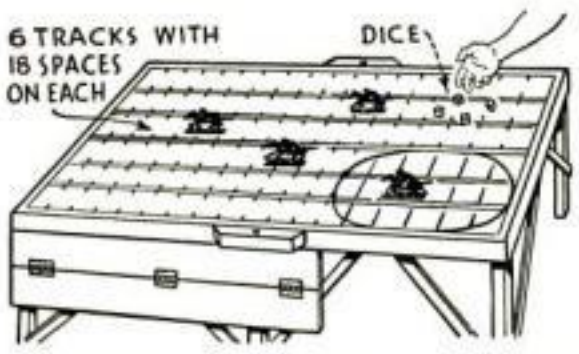
When windows in side curtains wear out, new ones are made of sheet celluloid. After the damaged curtain is cut out, as above, the new curtain is cemented to edge of old one as shown at right

SEVEN-IN-ONE TABLE

(Continued from page 61)

drinks at a soda fountain are especially suitable. Six table tennis balls are then tossed from the south end of the table so that they will, on their first or second bounce, land in a vase or a hoop. The score is 25 points for each hoop, 100 points for the small vase, and 200 for the large one, and 25 is deducted for each ball that goes out of bounds.

Now for that good old American game baseball. Fasten accessory *B* on the south end with its front facing north. Adjust accessory *A* on the north end, and see that the other drop leaf is hooked into place on the west side. Take several heavy table-tennis balls or, better still, inflated rubber balls of equal size. The player at bat stands at the north end and rolls the



A horse race on four of the six long tracks. The first horse up and down the table wins

first ball along the table to hit the wall *B* at the south end, off which it rebounds to the north end where it registers as indicated by lower figures on accessory *A*. The two triangular extensions of *A* stop stray balls from rolling out of the side troughs.

Balls remaining on the table count as foul strikes and are left there until the batter either is retired or reaches a base. Another ball is then used and if the second ball should touch the first, the batter is out as well as any batters on bases. In other words, this is a double play. Of course, three strikes retires the batter, four balls walks him, and three out retires the player.

The inactive player uses nails or long pegs to indicate the status of the side at bat by putting nails in the holes at the back of accessory *B*. At a glance the batter can see how many strikes and balls are on him, how many outs, men on bases, if any, and so on. Not unlike a good baseball game, the scores rarely exceed four or five runs in a nine-inning game.

For the bowling game accessory *C* is also attached at the north end and the baseball wall *B* is removed from the south. *C* forms a gutter into which the balls drop as they are bowled from the south end. The balls then roll into the tunnel under the table and are deposited in the receptacle at the south end of the tube. Again the ping-pong balls are used, as many as you have. A few red balls counting double add to the interest of this game. The upper numbers on accessory *A* are scored for this game.

The sixth game is similar to the horse race of shipboard fame. The table is ruled off for six lengthwise tracks, and these are divided as shown to give eighteen moves. Each player takes a horse and selects a track (numbered in the center of the table). The players then roll four dice and as many times as a player's number appears, he moves his steed forward. He also takes another roll every time his number appears.

Table tennis itself, of course, needs no explanation. It is the seventh game.

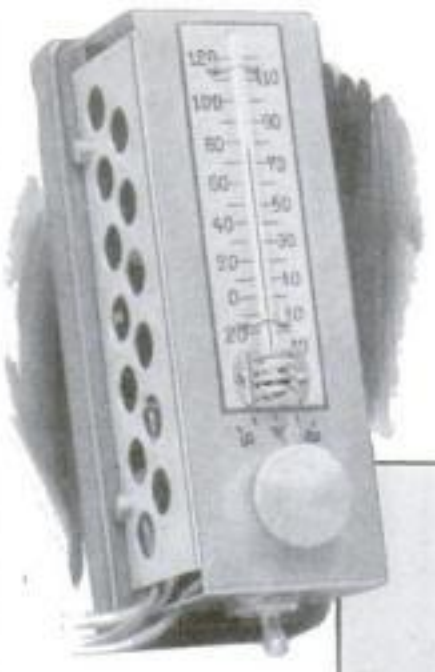
• • •

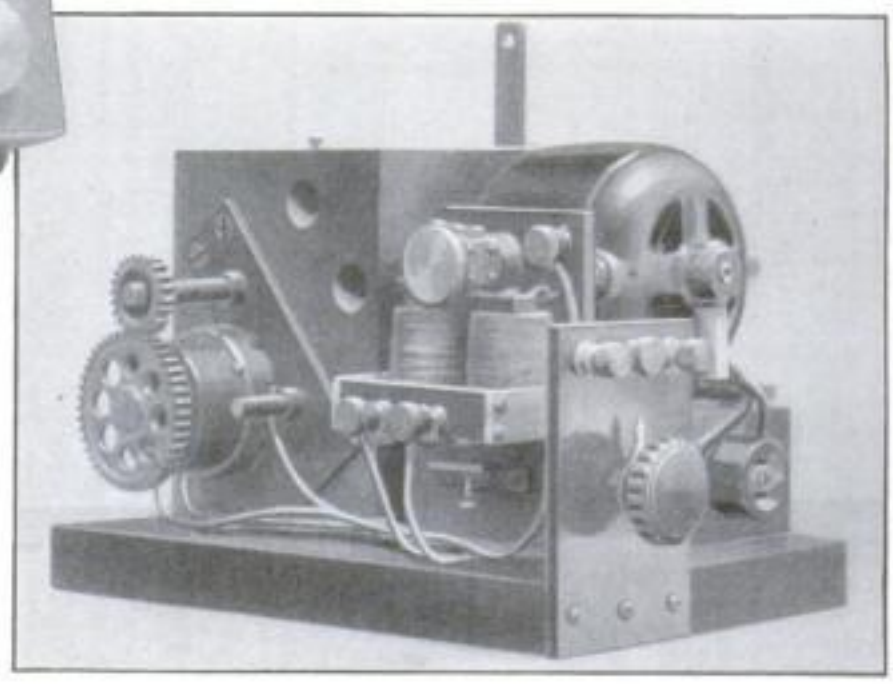
When ordering back issues of POPULAR SCIENCE MONTHLY, *please send 25 cents for each issue except the current one and the three issues immediately preceding. These four issues are only 15 cents each.*

Simple Heat-Control System

Saves Fuel and Insures Uniform Temperature

BY J. L. BIRD



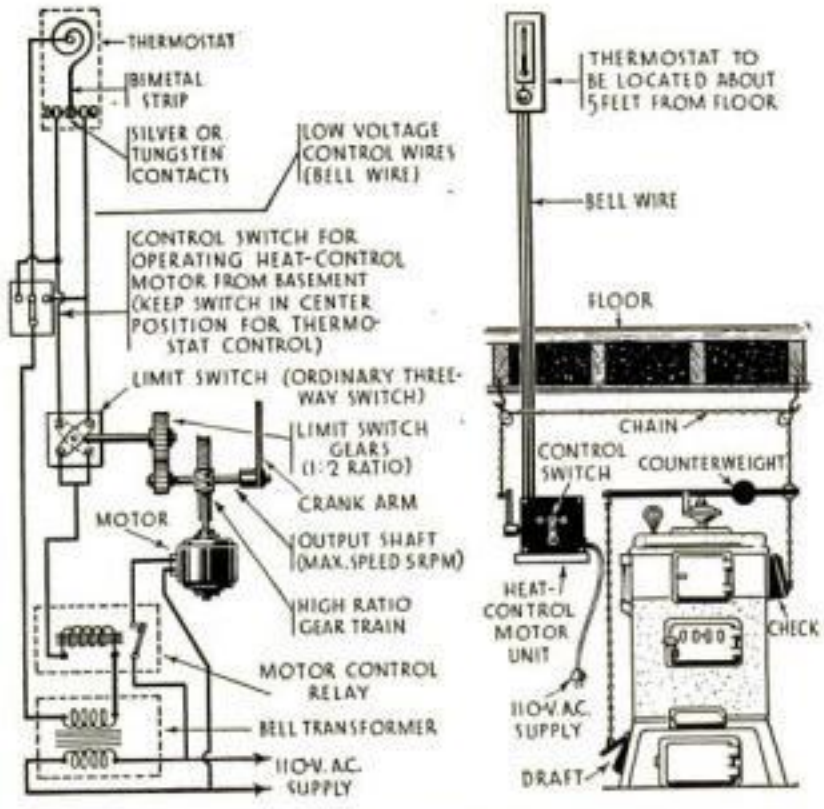


Above: The complete thermostat unit. The knob is set to whatever temperature is desired; thereafter the heat-control system operates draft and damper automatically. *Right:* The motor unit

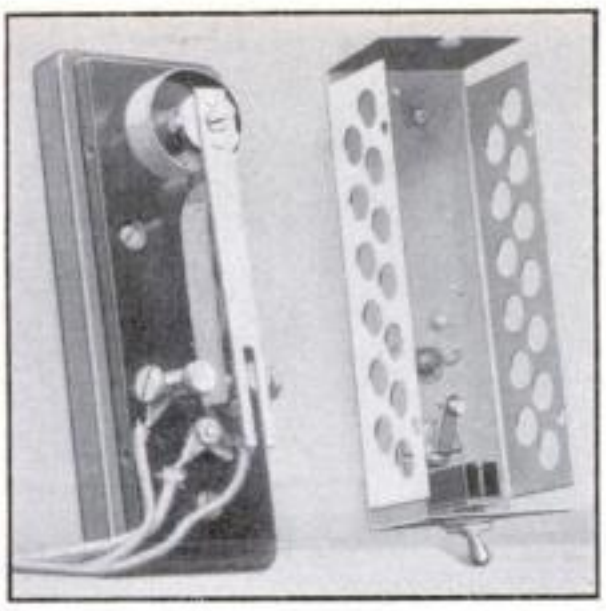
NEARLY everyone who has seen or heard about automatic furnace heat-control systems wishes that his home had one. It not only provides a uniform temperature, but also effects a substantial saving in fuel costs. The following description and illustrations will enable any man who is handy at making electrical installations to construct an efficient heat-control system at the minimum expense.

Heat-control equipment for a steam, hot-water, or hot-air heating system consists essentially of a room thermostat and a motor-driven device to operate the check and draft dampers on the furnace.

The thermostat is a bimetal strip shaped and mounted as shown. It is best to buy this thermostatic metal. He will need a strip from 8 to 10 in. long, ⅜ to ½ in. wide, and approximately .030 in. thick. The bimetal strip is soldered to a short piece of brass rod and then wrapped about it in a loose spiral for about half its length. At the end of the straight piece, solder a small silver or tungsten contact to each side. The short brass rod is next fastened to an insulating base of bakelite or similar material in such a manner as to enable it to turn, but not too freely. To the other end of the rod attach a long metal strip that will serve as the temperature adjusting lever. The fixed contacts also should have silver or tungsten tips. The holders



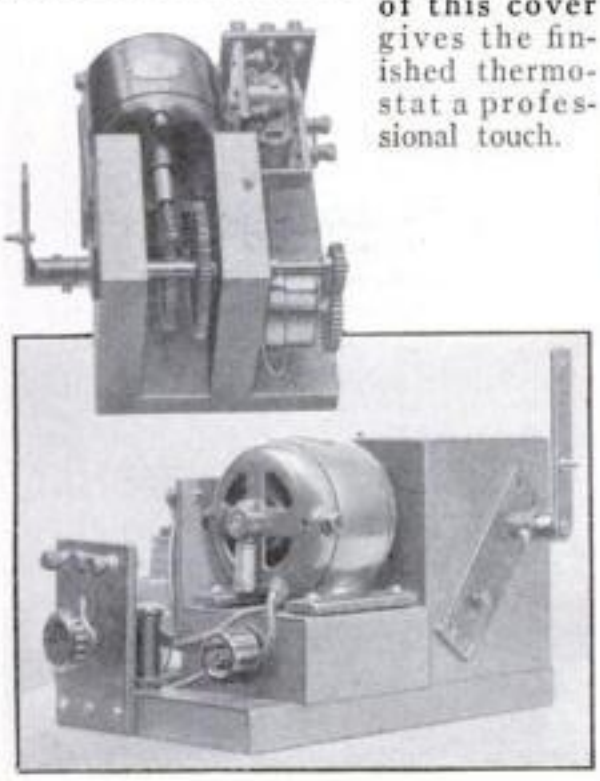
The wiring diagram and suggested method of installation. If a low-voltage motor is used, the relay shown will not be needed



The thermostat. Note at right the radius arm that works in the adjusting lever slot

for these may be made of ordinary binding posts. Mount them as indicated in one of the photographs. The gap between the fixed and movable contacts may be quite small (.004 to .006 in.) The electrical connections are the two fixed contacts and the bimetal strip.

The insulating base should be fastened to a wood strip, which will serve as a mounting plate. A ventilated cover may be constructed of sheet metal. An inexpensive thermometer mounted on the face of this cover gives the finished thermostat a professional touch.



Motor unit with gearing, crank arm, limit switch, relay, and fireman's control switch

The method of indicating the temperature setting of the thermostat may be varied to suit the skill of the builder. The long adjusting lever may be brought through a slot in the bottom of the cover and fitted with a pointer to indicate the temperature setting on a calibrated scale. The method used by the author was to mount a knurled knob on the top of the cover and arrange it to turn a small radius arm fitted with a pin that moves in a slot cut in the adjusting lever. This scheme provides a relatively large circular motion of the knob for a small movement of the adjusting lever, which results in greater accuracy in calibrating and in making temperature settings.

After the thermostat is completed, it must be aged. *(Continued on page 77)*

BLUEPRINTS

to aid you in your Home Workshop

TO ASSIST you in your home workshop, POPULAR SCIENCE MONTHLY offers large blueprints containing working drawings of a number of well-tested projects. The blueprints are 15 by 22 in. and are sold for 25 cents a single sheet (except in a few special cases). Order by number. The numbers are given in italic type and follow the titles. When two or more numbers follow one title, it means that there are two or more blueprints in the complete set. If the letter "R" follows a number, it indicates that the blueprint or set of blueprints is accompanied by photographically illustrated instructions which supplement the drawings. If you do not wish this supplement, omit the letter "R" from your order and deduct 25 cents from the price given. The instructions alone are sold for 25 cents each.

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(Construction kits are available for some of these models. See page 84)

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HEAT-CONTROL SYSTEM

(Continued from page 75)

This is accomplished by putting it in an oven at a temperature of approximately 250 deg. F. for a period of four hours, and then in a refrigerator for the same period. This aging process removes all stresses from the bimetal strip caused by shaping it to the spiral form.

THE calibration is to determine the position of the adjusting lever for every desired room temperature. Measure the room temperature carefully. Move the adjusting lever so that the bimetal strip contact is midway between the two fixed contacts. Arrange a simple electrical circuit employing lights or buzzers to enable you to determine when the bimetal strip moves and makes contact with either of the stationary contacts. Raise the room temperature about 1 deg. This may be done by bringing a source of heat in the vicinity of the thermostat. The strip will move over and touch one of the stationary contacts. Now, lower the room temperature slightly. The bimetal strip will touch the other contact on a change of 1 deg. from the normal room temperature. Repeat this test for temperatures ranging from 60 to 80 deg. F., which is the average temperature range used in the majority of houses. Carefully note the adjusting lever position for each temperature taken, and calibrate a scale of these positions. It is suggested that the scale be marked 60, 70, and 80 deg., with 5 deg. graduations. The operating differential, or change in temperature to which the thermostat will respond, may be varied by changing the contact gap between the fixed and movable contacts.

It is desirable, however, to have this gap as small as possible. A carefully constructed thermostat will operate on a plus or minus change of one degree. In other words, if the room temperature increases 1 deg. from the desired temperature, the thermostat will act in such a way as to cause the heating system to check itself; conversely, if the temperature drops 1 deg., it will cause the furnace draft to be opened.

The motor unit can take a variety of forms, although it is essentially a small fractional horsepower (ordinarily 1/50 H. P.) motor driving through a high-ratio gear train to an output shaft which makes but one-half revolution per movement. This half-revolution movement is accomplished by a simple limit switch.

A MOTOR-SPEED gear reduction assembly should be constructed of spur gears or worms and worm gears, so that the output shaft moves at a rate not exceeding 5 R. P. M. If the builder has available a motor with a self-contained speed reducer unit, he can save himself half the job of building this part of the equipment.

The motor and speed reduction gear train should be mounted on a suitable base. The slow speed output shaft should be at least 5 in. above the base. To this fasten a small crank arm with a radius of approximately 4 in. This crank arm is connected to a chain which operates the draft and check dampers.

The limit switch is a standard three-way snap switch geared to the output shaft in the ratio of 1 to 2. This gearing allows the output shaft to make one-half revolution while the snap-switch shaft rotates one-quarter revolution, which is sufficient to snap it.

The details of constructing the motor unit with its speed reduction gearing will be left to the builder's ingenuity, since its form depends entirely on the parts available. The photographs show a motor unit built by the author and may be *(Continued on page 79)*

Inlaid Paper Cutters

MADE FROM BUILT-UP STOCK

By L. B. HALAND

INLAY turning and the unfortunate results that arise from its indiscriminate application are reasonably familiar to most home shop workers, but here is another and more artistic form of inlay. It is a type especially adapted to perpendicular objects like billiard cues, walking sticks, pedestals for smoking stands, and, as the illustrations show, paper cutters.

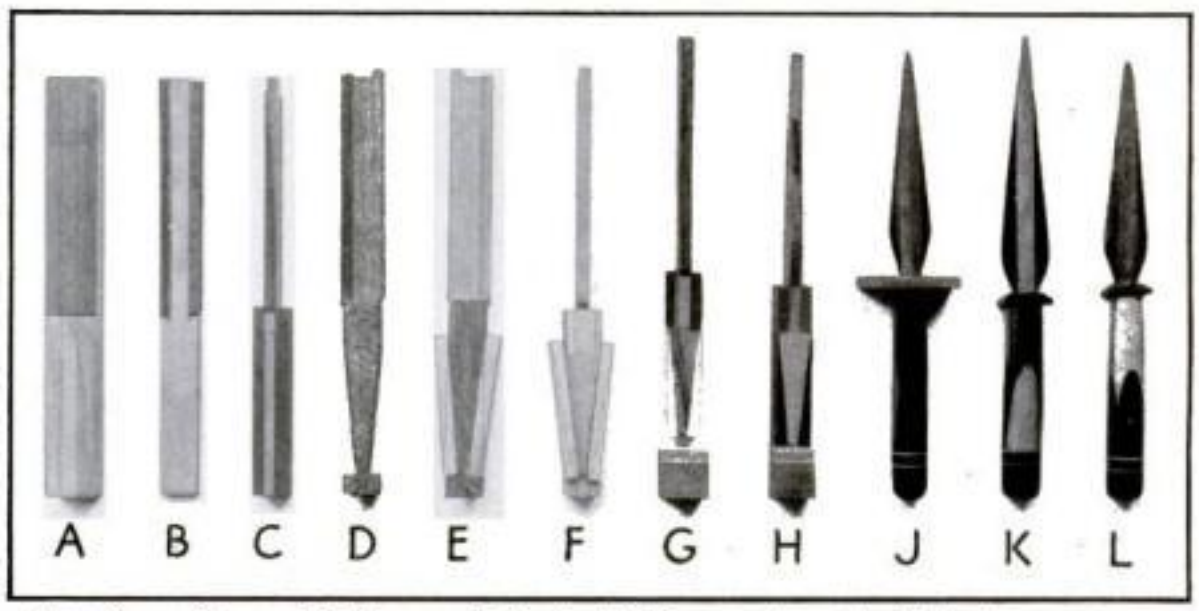
The start is made as at *A*—simply a T-shaped piece of wood to which two pieces of darker wood are glued. The added pieces are of a thickness to bring the sides flush. A slice is sawn from this piece as shown at *B*. *C* is the same piece turned in an edgewise position with two other blocks glued to opposite sides for giving substance to the handle.

Diagonal cuts are made on opposite sides of the handle as shown at *D*, blocks are glued in these cuts as at *E*, and the waste represented by the pencil lines on the handle is planed off flush. Exactly the same thing is done on the opposite two sides as at *F*, which shows two sides planed flush and smooth and the other two inserts in place.

When the last two inserts have been planed off parallel to the sides of the handle, the nib, which is about ¼ in. long, is sawed off square, and the knife has the appearance shown at *G*. In this illustration there appears for the first time the built-up end block, which in this case consists of a piece of plywood glued to another small block. The plywood accounts for the thin bands of color. The built-up block is now glued to the end of the handle, and the blade is roughly cut to shape as at *H*. The handle and blade are given their final form with sandpaper, and the guard is attached as at *J*. The guard is made from a small block of wood that is split, not sawed, and fitted around the handle. If this is done with reasonable accuracy, it will be next to impossible to detect the glue joint. The guard may be worked up into various forms, but the one shown at *K* and *L* is perhaps the simplest.

The knife is now ready for finishing by any of the familiar methods, the best being a clear polished finish.

If this method is to be applied to billiard cues, canes, and similar work, the process is identical except that, as the stock is to be turned, it will be square, so steps *A*, *B*, and *C* can be ignored. Simply follow the steps indicated at *D*, *E*, *F*, *G*, and *H*. Then place the work in the lathe and proceed with the turning in the usual way. In turning such long, thin work, particular care will be needed to avoid the chattering that results from pressure of the tool against the stock. A steady rest of some kind will be found almost indispensable, and also it may be found a help if a small block plane is used as a turning tool by supporting it against the tool rest so the plane bit will be at an angle.



Steps in making an inlaid paper knife by building up the stock. Billiard cues, canes, smoking stand pedestals, and various turned articles can be made in the same general way

HOLLOW PARTS FOR MODELS CUT FROM SHADE ROLLERS

BUCKETS for an old well model, funnels for ship models, or any similar parts about ⅞ in. in diameter can be made quickly from an old window shade roller. Remove the spring, which leaves a long wooden tube, and cut off a piece the height of the part to be made. Then carve the sides as necessary and glue in a small round piece of wood at the bottom. If desired, the wood can be covered with metal foil.—HARRY SCHMIDT.

HEAT-CONTROL SYSTEM

(Continued from page 77)

used as a general guide as to the form this apparatus should take. The motor may have either a 110-volt winding or a low-voltage winding. If a low-voltage motor is used, its power must be supplied from a transformer or dry cells.

It is recommended that the thermostat control circuit for this system be low voltage. This will enable the builder to run bell wire to the thermostat and not violate the house wiring code. A motor control relay will therefore be required if the motor used is wound for 110 volts. The wiring diagram at the bottom of page 74 makes provision for a relay in the circuit.

THIS control relay may be easily constructed from an old telegraph relay, sounder, or bell-magnet coils. Simply mount a contact on the moving armature and another on an insulated support, so that the two meet when the magnet coils are energized. The control relay should be mounted on the motor assembly.

The equipment is now ready for wiring and installation. The thermostat should be located in the living room or hall about 5 ft. from the floor. Avoid placing it near radiators, chimneys, or pipes (exposed or concealed), on outside walls, near windows, behind doors, or where it will be exposed to cold drafts or heat from kitchen stoves.

Run the three bell wires down to the basement where the motor unit is mounted. Carry the chain from the arm of the heat-control motor unit over pulleys to the dampers. Adjust it so that it lifts the draft and check damper the exact distance found necessary. Set the counterweight of the ordinary furnace regulator so that the draft damper opens and the check closes by gravity when no steam pressure exits. On rising pressure, the bellows will automatically decrease the draft. Experiment with the draft slides in the furnace doors to obtain best combustion.

In order to have electrical control of the draft and check while tending the heater or firing, it is well to include in the control circuit in the basement a three-point switch, as shown in the wiring diagram. This enables the fireman to operate his heater controls without disturbing the chain connections on the thermostat setting.

Connect the thermostat so that when the room temperature rises, the thermostat contact established will cause the motor to turn in a direction which will close the draft damper and open the check damper.

Mr. Bird has also devised a simple clock control to cause the furnace draft to be opened at any predetermined time in the morning so that when the home owner arises he will have a warm house. This will be described in a future article.

COPPER SULPHATE ADDS STRENGTH TO HEMP

IT HAS been discovered that the strength and endurance of threads, strings, ropes, and even woven materials made of hemp, linen, and other vegetable fibers may be greatly increased by treating them with a solution of copper sulphate, also known as blue vitriol, in water. The materials are soaked for from six to twenty-four hours in a solution containing from two to four percent of the copper salt and are then dried. If the stronger solution is used, the dried material should be watered again to remove an excess of the copper salt or traces of sulphuric acid that may have formed. Having become dry, the treated material shows a slightly greenish color and a considerable increase in its strength and resistance to climatic conditions.—E. WELLECK.

A MODERN-LOOKING Scoop-Seat Stool

For Beginners in Woodwork

By Herman Hjorth

Author of *Basic Woodworking Processes* and *Principles of Woodworking*

The design for this easily made little stool was suggested by an expensive handmade modern piece

A SCOOP-SEAT stool is a convenient piece of furniture because it takes up so little room and can so easily be pushed out of the way when not in use. A stool of this kind is useful in the dinette, in the bedroom before the dressing table, in the boy's room, as a desk chair, or even as a piano stool. Moreover it is very easy to make, requires but few tools and little experience, and can be constructed almost entirely from a ⅞-in. board.

The four legs should first be made. It is easier to rip and plane two 32-in. strips to dimensions and then saw them to length than it is to plane four 16-in. strips all alike. The first method should therefore be used if possible. The eight pieces forming the frames should be planed to width and cut to length in a similar way. The faces of these pieces, however, should not be planed until after the frames have been doweled together.

The doweling is unusually easy to do. Lay out for the dowels as shown, clamp the four pieces together in the position they are to occupy when finished, and bore the holes through the vertical pieces and 1 in. into the horizontal pieces. Use a gage on the bit to get all the holes uniform in depth.

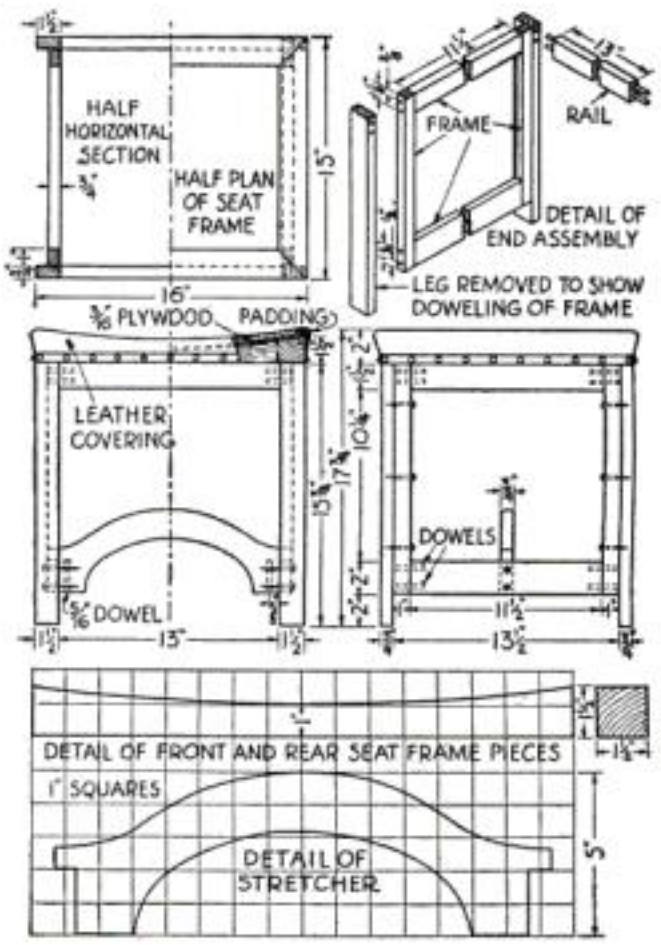
Cut the dowels ⅛ in. shorter than the depth of the holes, put glue into the holes and on the ends of the horizontal pieces, dip the dowels in glue, and drive them in place. Clamp the frame as before and pull all the joints tight. This can be done now even if the clamps are placed right over the ends of the dowels, because the dowels are ⅛ in. shorter than the depth of the holes. Test for flatness by placing a steel square across the vertical pieces.

When the glue is dry, the clamps are removed and the frames smoothed on both faces with plane and sandpaper. Test for flatness with a steel square while planing.

The frames and legs are now joined with 1½-in. No. 9 round-headed screws. Bore 3/16-in. holes through the frame for these screws. If the wood is soft, as for example whitewood or Philippine mahogany, no holes need to be bored in the legs. If the wood is hard, small holes may be made in the legs with a bradawl. Use soap on the threads of the screws; this acts as a lubricant and makes them easier to drive.

The two ends of the stool are joined with two rails, doweled between the legs, and one stretcher that is screwed to the lower horizontal pieces of the frame. A center line is gaged on the ends of the rails and on the upper part of the edge of the legs. Gage from the outside faces only. The marking gage is then set to 1⅛ in. and a second series of lines is gaged across the center lines. Bore holes where these lines intersect and cut the dowels ⅛ in. less in length than the combined depth of the holes.

The stretcher is laid out according to the detail drawing. Its lower part is a half ellipse. Before cutting the stretcher to shape, bore two holes as indicated and glue dowels



Assembly drawings, sketch showing how frames are assembled, and details of the shaped pieces

into them. This is so that the screws, which hold badly in end wood, will get a better grip by going through the dowels. The stool is now glued and screwed together. When dry, any unevenness between rails and legs is smoothed off with a plane and sandpaper.

The seat frame consists of four pieces 1½ by 2 in. They may be made from ⅞-in. pieces glued together. The front and rear pieces are shaped as shown, after which the pieces are mitered, glued, and nailed. The end pieces are then planed to conform to the shape of the front and rear pieces. A piece of ⅛ or 3/16-in. plywood, such as can be obtained from a packing box, is glued and nailed to the seat frame.

It is best to stain and finish the stool before tacking the upholstery in place. The simplest way to finish it is by brushing on three or four coats of very thin shellac. Allow each coat to dry at least four hours and rub it down with No. 2/0 or 3/0 steel wool. Buy what is called a "5-lb. cut" of prepared shellac and thin it with denatured alcohol

List of Materials

No. of Pieces	Description	T.	W.	L.
4	Legs	¾	1½	15¾
4	For frame	¾	1	13¾
2	" "	¾	1½	11½
2	" "	¾	2	11½
2	Rails	¾	1½	13
1	Stretcher	¾	5	14½
2	Seat frame	1½	1½	16
2	" "	1½	1½	15
1	Plywood top	3/16	15	16
26	Dowels	5/16	round	2
12	Round-headed screws	1½-in. No. 9 screws		
4	" "	2-in. No. 9		

NOTE: All dimensions are given in inches and are finished sizes.

until it is as thin as water. The last coat may be a little thicker and may be rubbed down with waterproof sandpaper No. 7/0 and crude oil.

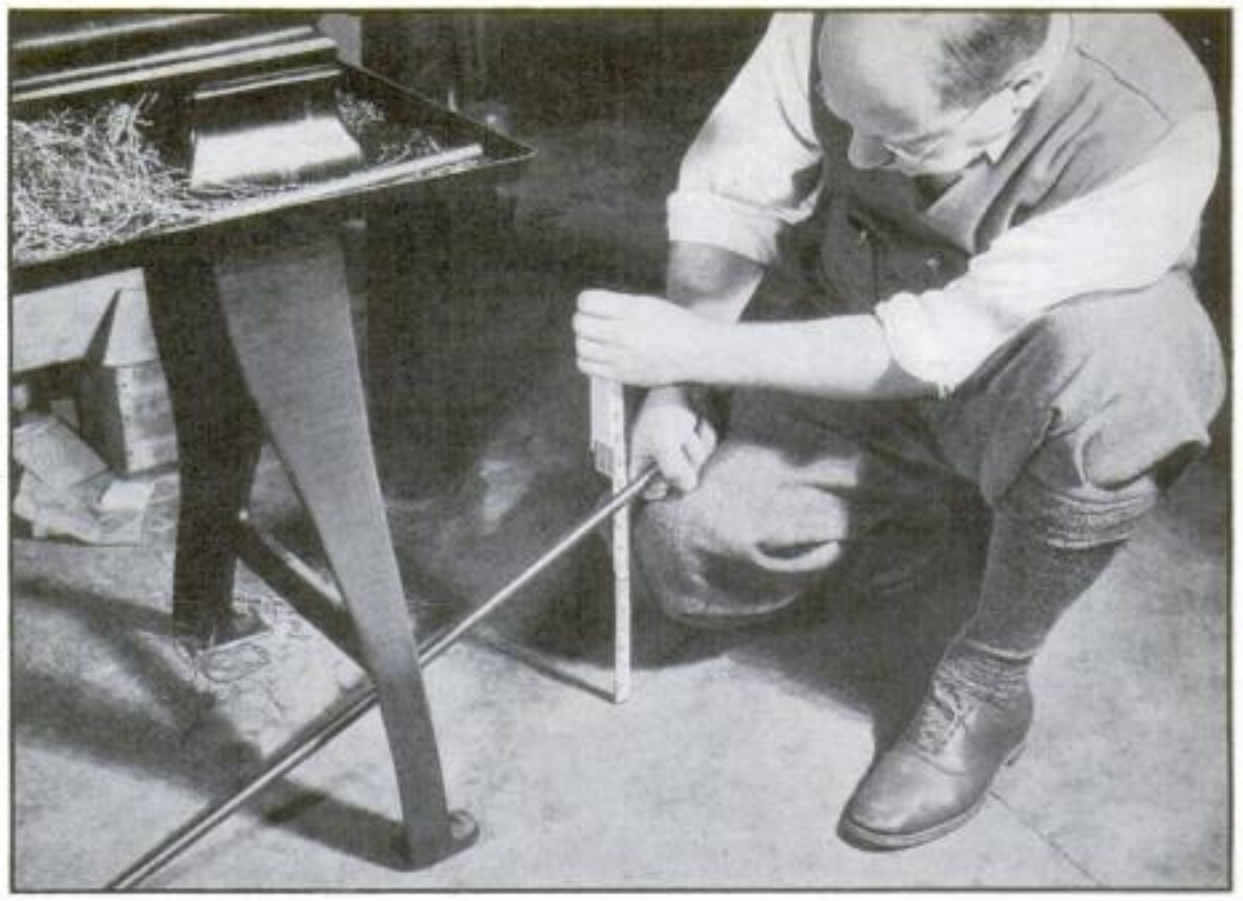
The upholstering may be done by stretching piece of an old quilt or a double layer of so-called "silence" cloth (the material used under tablecloths) over it and tacking it to the sides. The covering, which may be imitation leather, is stretched and tacked flush with the lower edge of the seat frame. A narrow strip of the same material, called "gimp," is nailed along the edge with fancy upholstering nails.

CHEMICAL SOLUTIONS SEALED WITH WAX

SEALING chemical solutions in their bottles with paraffin wax, the kind used for preserving jelly, will result in their keeping for a much longer time than could ordinarily be expected. This applies to any solution that loses strength on oxidation, and especially to photographic chemicals. It is necessary to use some care in pouring the wax on top of the liquid, so that it will cement itself to the sides of the container, and not merely float. Developer has been kept almost crystal clear for months this way, while bottles of the same solution which were merely corked became dark brown.—JACK FEELEY.

HOW TO PREVENT SQUARE-KNOT WORK FROM RAVELING

THOSE readers who are doing square-knot work like that described in many articles in POPULAR SCIENCE MONTHLY, will find it a good idea to soak the end of a completed project in water and allow it to dry before cutting the cords off short. This causes the knots to shrink tightly and prevents raveling.—K. M.



HOW TO STRAIGHTEN
Long Turned Bars

Two easy ways in which the amateur machinist can remove the kinks that are likely to develop in slender turnings because of internal stresses

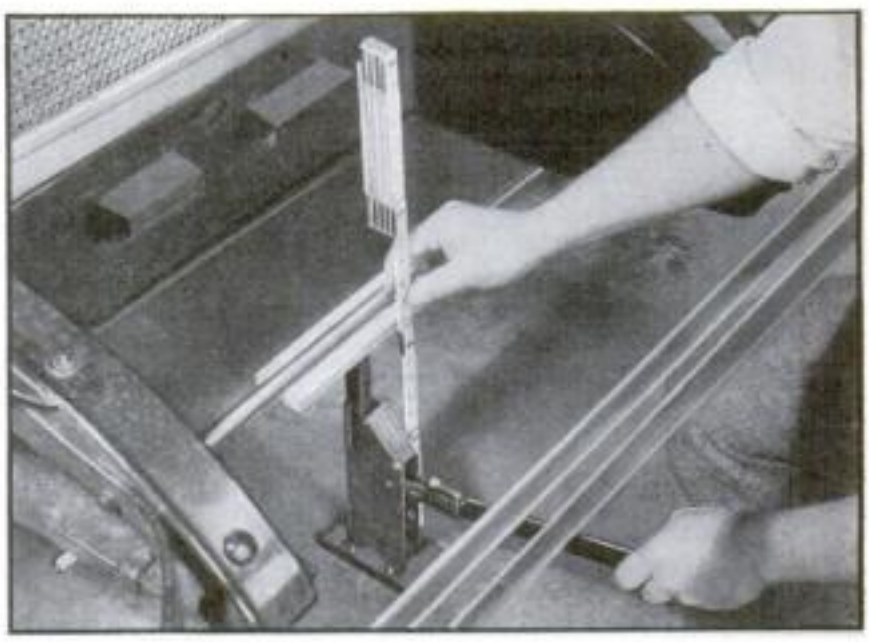
By THOMAS W. ARNOLD

THE modern screw-cutting engine lathe is a tool of high precision designed to eliminate the uncertainty of human hands. In spite of that, one of the most delicate of the operations in turning a long, slender piece still remains essentially a hand job.

When you turn or cut a thread on a long bar of steel, the altered internal stresses in the material almost invariably pull it out of true. The only solution is a straightening job.

In firearms factories, the men who straighten barrels attain an almost unbelievable skill. The common method is to place the barrel across the jaws of a horizontally placed V-shaped piece of metal with the high point over the opening in the V. Then a heavy blow is struck on the high spot with a soft metal hammer. Experts can take all the kinks out of a barrel with just a few properly placed blows of a hammer. But, as I can testify from personal experience in firearms factories, it's not as easy as it looks. You are more likely to put more kinks in than to take out those already existing.

The photograph below illustrates one of the safest ways to straighten bars in the home workshop. The idea, of course, is to hold both ends of the bar while you apply force at the kinked point with whatever means are available. In the case shown, the bar happened to be long enough to reach across from one front spring of the car to the other with a few inches to



Using an auto jack to straighten a long, partly threaded bar

spare. The car's jack supplied the leverage to obtain sufficient pressure.

You will see that there is a small block of wood between the jack and the partly threaded rod. This is necessary to protect the thread and to spread the pressure over several inches of the rod.

Remember that brass, steel, iron, and most other metals have what is known as an elastic limit. You can bend them up to a certain point and they spring back to their original shape when the pressure is released, but if you bend even a trifle beyond that point the material takes a permanent set.

Suppose the bar you are turning develops a bend. The first job is to locate the high point of the bend as accurately as possible and mark the opposite side with a bit of chalk. Now set the bar ends against the supports so that the chalk mark is opposite the point where pressure is to be applied.

Note the reading of the rule to the sharp edge of the wooden block, and apply pressure. Bend the bar only a little, again read the rule, and release the pressure. Put the bar back between the lathe centers. If the kink is still there, repeat the process, this time applying a bit more pressure so the reading of the rule is a little greater. You will find, once you reach the elastic limit for the particular bar you happen to be straightening, that an increase in the bending of only 1/16 in. may be sufficient to complete the straightening.

The illustration at the head of this article shows another way of applying pressure. In this case the fixed points are at one end and the high point of the kink at the center of the rod. Although this method looks as though it would require a lot of strength to bend the rod, it is much easier than it seems. By lifting with your shoulder muscles and at the same time swinging your body backward to lift the knee against which your lifting hand rests, you can exert an amazing amount of upward strain. Don't attempt to do this unless the lathe legs are firmly bolted.

ETCHING STEEL TOOLS

ANY home worker may easily etch his tools with the same method used by manufacturers. The chemicals, which may be obtained at any drug store, are: nitric acid, 8 oz.; muriatic acid, ¾ oz.; and alcohol 1½ oz. Add water to make 3 pts. The so-called "resist" is made of gum guaiacum to which is added enough acetone to obtain a consistency like varnish. As a substitute resist, heavy varnish or melted beeswax will answer the purpose.

Give the article to be etched a good coat of the resist compound and allow to dry thoroughly. Moisten the required rubber stamp in a solution of ½ lb. caustic soda to 1 pt. water and press the stamp firmly on the spot to be etched. The article is then immersed in the etching solution until the proper depth of etching is obtained. The resist is removed by washing it off with the caustic soda solution. A small amount of this latter solution should be kept in a separate container for treating the stamp.—HECTOR J. CHAMBERLAND.

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All kits are accompanied by instructions or blueprints. The list continues on the following page.

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D. Spanish galleon ship model, 24 in. long. All the raw materials (except paints), Blueprints Nos. 46 and 47, and a booklet 6.45

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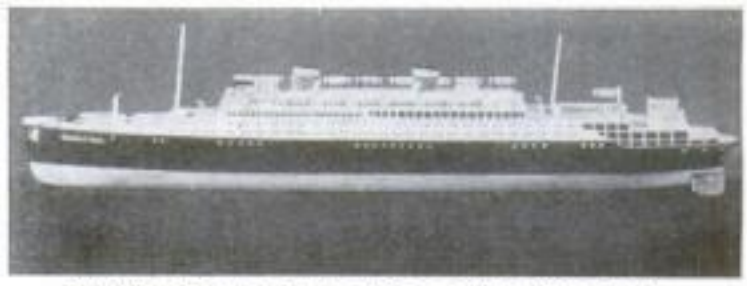

KIT F—Materials for 12-in. model of *Manhattan*

KIT H

KIT D

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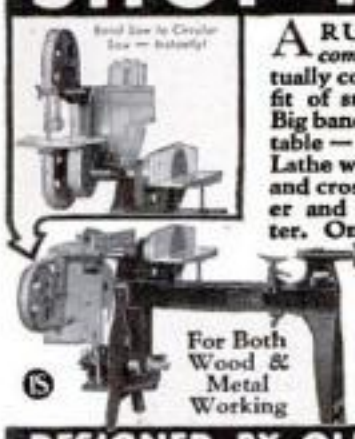

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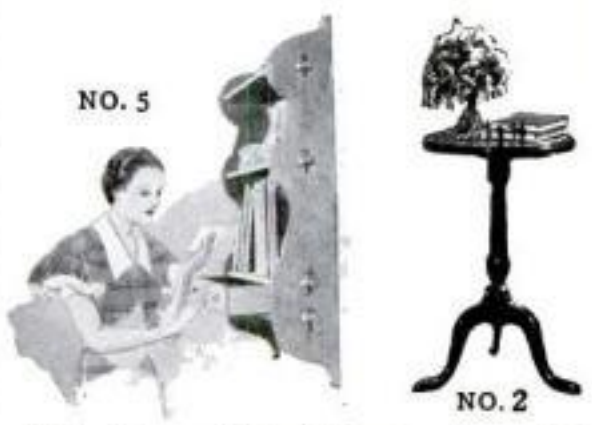

EE. Same with hull lifts sawed.... 7.45

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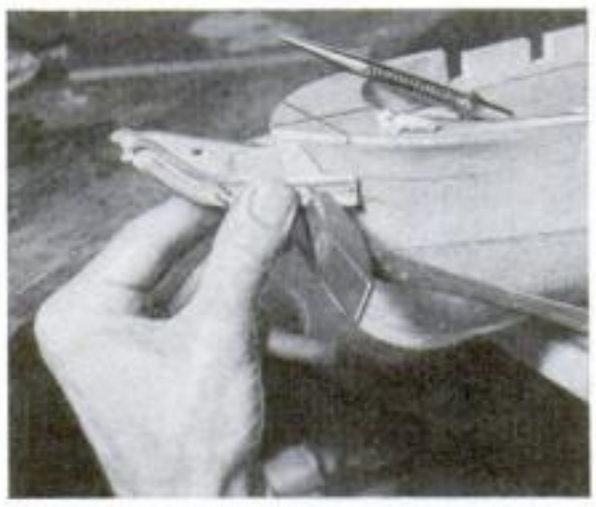
FINISHING HULL OF *HARTFORD* MODEL

(Continued from page 67)

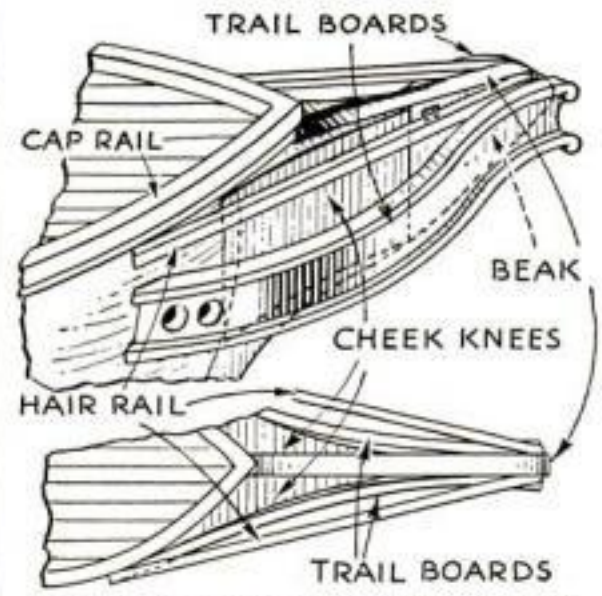


Fitting trail boards to cheek knees. Photos of the finished head will be published later

one on each side of the gangway, and one in between. If you use slightly thicker wood for the sides and rabbet them to leave a light molding at the top edges, that will look still better. They might be made solid with a white stripe down the middle, or they might be made deeper with their top edges carved to represent the hammocks in position. At the gangways they will be cut away and gangway boards made to fit their edges. These boards were elaborately carved, but on the model are too small for this. They had better be left off for the present.

Inside, where the bulwarks meet the deck, waterways should be glued. They are 3/32 in. by 1/16 in. deep, with the corner planed off. Two holes may be bored on each side for scuppers. They will be 1/16 in. in diameter, from inside the waterways sloping down to the outside. They would be between gun ports 6 and 7 and 9 and 10. See the drawing in the following column.

The fittings under the forecastle should now be added so that we can get that deck on. Two of the riding bitts *W* go there. They are heavy round bitts on solid iron shoes, but can be made of wood and nailed down in the position shown. The hawse pipes must also be bored. They will be 3/16 in. in diameter, but



Sketch and plan view of the head. Compare with the photo on page 57, January issue

start with a smaller drill first. As we have a lot more wood here than there should be, they are awkward to cut, and you will have to bore from both inside and outside. You may find it necessary to bring the starboard chains inboard to port, and vice versa. Make sure that, with the aid of a fine wire, you can reeve chains through them.

Take a piece of 1/8-in. white pine and mark it for the forecastle deck. The correct method of doing any marking of this kind is shown in the photograph on page 87. Glue and nail the forecastle deck on so that it lies over all; then turn a stanchion *Q* as shown on page 67 to support it amidships, and press it up slightly to give the camber. This deck should be level with the top of the hammock rail. (The poop deck, it should be noted, its formed by lift G.)

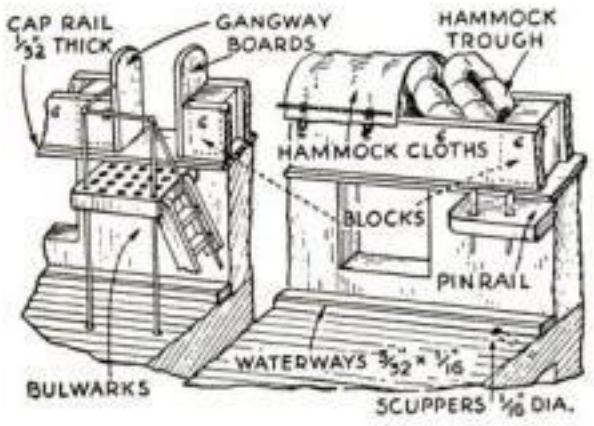
Cut 1/16 by 3/16 in. covering boards to extend from the stem to the middle of gun port 3. It is easier to cut these than to bend them to shape. Across the after edge, fasten a similar piece. The cap rails are a full 1/8 in. deep by 1/16 in. They had best be bent into position so as to meet at the stem. In them are cut notches for the mooring chocks and catheads, which can now be fitted. The catheads are 3/16 in. square by 1½ in. long, 5/8 in. of which is outboard. In the extreme ends of each, six holes are drilled to represent the catfall sheave holes. Inside of these on the foreside are three eyebolts made of wire, or ½-in. pins with their ends clinched abaft. Underneath is another eyebolt for the stopper. The inside ends of the catheads are chamfered to rest on the deck when these pieces project up and out across the covering boards.

The edge of the poop also will need a 1/16 by 3/16 in. covering board. This is most easily cut from a piece of wood as shown in a photo. Across the fore goes a thinner piece.

The inside of the cut-out part of the poop should be painted white. At the bottom place a little grating hatch, and on the poop bulkhead, overlapping the opening, glue a thin frame. This bulkhead will also have a door on either side, which may be indicated with V-cuts or merely painted on.

Amidships under the gangways there is a series of cleats on the hull on both sides, forming grips and steps by which one can come aboard when no ladder is out.

The propeller should now be made and fitted. The original one was 14 ft. in diameter



How the hammock trough is constructed. Note the gangway boards, waterways, and scuppers

and two-bladed. I carved mine in wood and painted it bronze color but, of course, a cast bronze one would be better. In making the hull I found it easier to shape the stern like a sailing ship's rather than as shown in the body plan. If it is made thus it will now be necessary to fasten on either side rounded wedge-shaped pieces to form the thickness for the propeller shaft. These pieces can be glued on and the copper sheathing brought over them. The shaft is 5/32 in. in diameter. In 1880 a four-blade screw was fitted, and the original was made into the statue of Admiral Farragut that stands in Farragut Square, Washington, D. C.

The rudder requires four pintles and gudgeons, fitted in the usual manner. For the rudderpost just bore a hole in the counter. To make a working rudder is difficult and unnecessary. It would have to be fitted before applying the top lift or deck.

The channels, to spread the rigging, should be nailed on before the hull is painted. They are shelves slightly thicker at the back than the front, with their *(Continued on page 87)*

THE *HARTFORD* MODEL

(Continued from page 86)

upper surfaces horizontal, and have notches cut in them at the correct angles to take the chain plates. They should be firmly fixed and painted black.

Between gun ports 2 and 3 it is necessary to place smaller platforms; these are the billboards for the anchor flukes to rest on.

Fastened to the stem just above the water line are two straps with eyes in the end to take the bobstays. These can be made from sheet

Marking a thin board to serve as the poop covering board. A piece is marked similarly for the forecastle deck and covering board

brass. If the straps are drilled carefully, ½-in. pins can be put right through and clinched on the other side; this will hold them with adequate firmness.

As mentioned before, the hull will be black from the water line, with a white stripe along the gun ports down to the deck level. The headboards will be black, with white moldings and ornamentation. There is black on white and white on black ornamentation on the stern galleries, and the name "HARTFORD" with three stars beneath is painted black on white at the stern. I applied the ornament on the trail boards by painting them white and outlining the scrolls with a fine pen and India ink, and made the other ornaments similarly.

The holes for the masts may now be bored. I set the hull firmly upright and level, and then made rectangular blocks of which one face was at the angle or rake of the mast. I held this firmly on the deck and kept the drill along its face. The diameters of the masts at the heel are: foremast, $\frac{5}{16}$ in.; mainmast, $\frac{3}{8}$ in.; mizzenmast, $\frac{1}{4}$ in.

(To Be Continued)

Note: *In building the* Hartford *or any other ship model, you will be greatly helped by reading Captain McCann's articles on tools and materials, hull construction, and small fittings previously published (P. S. M., Sept. '33, p. 60, Oct. p. 68, and Nov. p. 66). This series of general articles on ship model construction will be continued at the conclusion of the* Hartford *articles, or earlier if space is available. The next article in the series gives easy ways of making lead castings, davits, deadeyes, and blocks.*

The name of the warship and the three stars are painted in black on white at the stern

SEA WONDERS THROUGH A MICROSCOPE

(Continued from page 37)

enough light to permit the use of the substage mirror. Focus on one of these thin places, using fifty to 100 diameters magnification.

In an instant, your conception of sea shells will change. The first glance reveals a beauty the existence of which you never dreamed. Your first thought, probably, will be of a beautiful mosaic tile floor, perhaps one that is enlivened with color. The sight that greets your eyes is an expanse of tiny blocks or prisms, perfectly fitted together. Some of the blocks are large, some are tiny; but in general they are fairly uniform in size. They differ, too, in shape—but you will find that most of them have six sides. Often in the same shell you will see masses of blue, yellow, brown, black, and clear prisms. Sometimes there is a rainbow color effect that is indescribably beautiful.

The shell layer that exhibits this formation is made up entirely of little prisms joined together edge to edge. Their ends form the two respective surfaces of the layer. This prismatic layer is composed largely of carbonate of lime, the same material found in the skeletons of some sponges and in cuttlefish-bone.

AN INTERESTING little experiment indicates that lime is not the sole substance used in constructing the mosaic. Select a piece of shell that clearly exhibits the prismatic structure, and place it in a drop of dilute hydrochloric, nitric, or sulphuric acid. It will bubble violently, indicating that the lime and acid are reacting to produce carbon-dioxide gas. When the bubbling has ceased, remove the piece of shell and you will find it has lost its stiffness. If you now place the shell on a glass slide and slip it under the microscope, you will see the same mosaic formation, though perhaps changed as to color and general appearance. Now very carefully introduce a sharp-pointed needle into the field of view and press the edges of the piece of shell against the glass slide. The prisms, formerly so resistant to breaking, now crush easily into a shapeless mass.

Apparently the layer of prisms, the individual prisms even, are protected by a thin skin of horny-like material. Zoologists say that the horny outer layer, found on the surface of mussel and similar shells, protects the lime-containing layers beneath from carbonic acid in the water, and also imparts to the shell much of its color.

Would you like to know the secret of the pearl's popularity? Your microscope can tell you.

Turn to the inner pearly layer of the shell and examine it with your unaided eye. The surface reflects light in prismatic colors of great delicacy, and it has a luster that is found in almost no other substance.

PLACE the shell under your microscope and, at say 100 diameters, you will see the reason for much of this beauty. You will find that the surface is marked with many fine, wavy lines that run almost parallel to each other. There seem to be alternate ridges and furrows. The distinctness with which you see the lines depends on the manner in which you illuminate the shell. Some specimens are thin enough to be examined by transmitted light; but usually you will have to employ reflected light. If there is too much illumination, you will see only a glaring circle of white. Often the introduction of a color filter into the light beam will bring out the detail.

There seems to be some difference in opinion as to the exact nature of the pearly structure. Some investigators suggest that the furrows and ridges that mark the surface are outcroppings of layers of thin plates, or laminae. Others say that the lines are caused by folds or plaits in a single membraneous layer, the folds being at an angle to the surface. The iridescence of light rays reflected from the edges of the folds and from the furrows between them.

The pearly luster results apparently from the action of light that is reflected by the various transparent layers, together with that reflected from the surface. A spherical pearl, the kind prized as a jewel, likewise is composed of thin layers which reflect light in a similar manner. The thinner the layers, the better the luster. That is the reason why salt-water pearls, which have thinner folds, are superior to fresh-water pearls.

YOU will discover many other things about sea life by making microscopic examinations of commonplace objects such as those already mentioned. If you live near the ocean, or ever get the chance to make a seashore visit, you are prepared, with this meager introduction, to embark on a trip of microscopic exploration that will rival in excitement and interest the most unusual experiences of surface-going explorers.

During such a seashore visit, you will be wise to collect material with which to make permanent microscope slides. In fact, one of the most fascinating phases of amateur microscopy is the creation of a slide library. If you find, for example, a piece of sea shell that exhibits the mosaic-like structure unusually well, you ought to mount it permanently for future examination and exhibition to friends. Simply clean it well, dry it, and mount it in a balsam-filled cell.

If you follow the established method of making a cell for mounting thick specimens like the piece of shell, you will spin a shellac ring on the surface of the slide; then you will fill it with balsam, introduce the object and finally apply a circular cover glass. The chances are that, out of a dozen shellac rings, not more than half will be perfect—unless you are blessed with considerable skill or long practice.

There is a method, however, of constructing perfect cells in a minimum of time. The process consists of placing beneath the cover glass a washer whose thickness is sufficient to provide space for the specimen. The washer may be made of some transparent material such as celluloid, or of an opaque substance like thin paper. The outside diameter of the washer is the same as that of the cover glass. In mounting specimens, simply smear a little balsam on the slide, place the washer on it, apply more balsam to the cavity and upper surface of the washer, introduce the specimen, and drop the cover glass into place.

MAKING the washers is not difficult if you have a suitable punch. If you have access to a metal-working lathe, you can construct one in a short time. Otherwise, you can have a machine shop make one for a few cents. The punch consists of a steel rod having one end turned so that two circular cutting edges, concentric circles, are formed. The outer circle is of the same diameter as the cover glass. The inner one should be about one-fourth-inch smaller in diameter, producing a washer having a section one-eighth-inch wide. For very small specimens, the central hole can be smaller.

Cutting edges of the punch should be as sharp as possible. There is no need to harden the tool, as it *(Continued on page 89)*

WONDERS OF THE SEA THROUGH A MICROSCOPE

(Continued from page 88)

seems to stand up well without special treatment. Use drill rod or tool steel for the material. After the lathe work is finished, drill a small hole so that it runs at an angle from a point between the two cutting edges to a point in the side of the tool an inch or so from the end. Into this introduce a nail with a rounded point. This arrangement is necessary in order to remove the rings that frequently become wedged tightly between the cutters. An alternate method is to fill the cavity between the cutting edges with resilient rubber which expands after the hammer blow and expels the washer.

OLD photographic film from which the emulsion has been removed by soaking in a hydrochloric-acid solution, sheet celluloid such as that sold for automobile curtains, heavy paper, and similar materials can be used for the washers. You can cut a hundred of them in a short time. Use, if possible, stock of several thicknesses, for different sized specimens. In cutting, simply place the stock on a block of hardwood, set the punch on it, and strike the head with a hammer.

You will find that the use of pre-cut rings will give a professional appearance to your work. You can add a finishing border of asphalt varnish if you wish; or you can cut similar washers, slightly larger than the cover glass, from colored, gummed paper, and paste them over the cover glass edges after the balsam has set thoroughly.

The washer system can be used for square cells as well as round, if you make a tool for cutting square washers. Usually, however, the circular form is preferable.

Unless you live in some kind of Utopia, you will find that dust quickly collects on your microscope and other equipment if left standing in the open for a time. One of the most dangerous enemies of a microscope is the grit and lint that settle on it from the air. In well-equipped laboratories, glass bell jars are employed for covering microscopes when not in use.

A BELL jar, you will discover if you set out to purchase one, costs money. However, there is a way in which you can make a serviceable one, at a trifling cost.

From a drug store obtain a glass jug or bottle. For most amateur microscopes, a one-gallon size is sufficient. Select one that is made of clear, uncolored glass. The next task is to remove the bottom. This is accomplished most surely and easily as follows:

Clamp an efficient glass cutter to a block of steel or wood and adjust it so that the cutting wheel will touch the glass jug at a point three-fourths to one inch from the surface on which both the jug and block are resting. Rotate the jar, pressing it against the cutter wheel so that a line is scribed in the glass. You will be wise to wear gloves during this and subsequent operations.

After the cut has been completed, introduce into the jar a hammer made by bending a one-fourth-inch rod of iron at right angles an inch or so from the end. Tap the glass lightly opposite the cut, continuing around the jar until the line has broken completely through. The bottom will drop off cleanly.

With a file wet with turpentine in which some camphor has been dissolved, you can remove the sharp glass edges as easily as if they were made of brass. Finally bind the cut edge with one or two layers of adhesive tape, insert a cork into the opening at the top, and your bell jar is complete. The taped edge, besides being more attractive than the somewhat ragged glass, is dustproof and prevents damage to the microscope if the jar accidently strikes it.

Secrets of Success

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EDITOR'S NOTE: *This month we depart slightly from our course of printing in these columns true success stories as submitted by our readers. The biographical sketch below has, we believe, sufficient inspirational value for all young men to justify its appearance here. It is the story of a man who started with no more equipment in life than the average American citizen and who now, at an incredibly young age, has risen to tremendous prominence in the business world.*

• • •

FROM AUTO TINKERER TO BATTLESHIP BUILDER

A YOUNG chap of 20 whose sole interest in life seemed to consist of tinkering and fussing with old cars drove out of a dealer's yard in a battered flivver. Three weeks later he sat behind the wheel of a shiny maroon speedster. He had fixed up the old wreck, made a couple of shrewd swaps and emerged with a car worth $750.

Errett Lobban Cord didn't stop there. His love of cars kept him constantly on the fringe of the automobile world—even if it was the outermost fringe, such as junk yards and second-hand auto lots. Today, at 38, he is a monarch in the transportation kingdom. In the space of 18 years he has spread his rule over almost everything that moves—automobiles, railroads, ships and airplanes! He has fought amazing financial battles with Wall Street and emerged victorious!

It all started in the automobile business, which he entered as many another young man does, drifting into it because he likes to be around cars and to tinker with them. Cord rebuilt flivvers and sold them. He took a job as a salesman in a Los Angeles agency. He obtained backing for a string of filling, greasing and washing stations.

WHILE directing these and making them pay, Cord took his first flyer in transportation, operating a hauling service for mines in the mountains of Arizona. But he found this service as slow in profits as it was in actual motion. Back to the washing stations he went—to learn his first lesson. Trying to expand this business too rapidly for its own good, the bubble burst and left Cord without ownership and with no assets other than his own capabilities and his knowledge of motors.

(Continued on page 91)

Secrets of Success

FROM AUTO TINKERER TO BATTLESHIP BUILDER

(Continued from page 90)

In 1919, at the age of 25, he arrived in Chicago practically broke. Forced to take the first thing at which he knew he could make money, Cord went with the Moon Auto Agency. Here he caught on, selling cars so well that he rose to district manager, then general manager and soon he acquired an interest in the business.

In 1924 he was made manager of the slowly dying Auburn Company. In two years he was president and owner. The bankers who had brought him in to save the business were out entirely.

When he came to Auburn he found an immediate opportunity to cash in on his former experiences with old Fords. The company was loaded up with a lot of obsolete models. He had them repainted, altered them a bit and sold them out at fire-sale prices. This netted the company half a million dollars. Debts were paid off. A year later the market was swamped with snappy Auburns at then unbelievably low prices. Auburn stock soared wildly—and Auburn Motors paid a dividend. Into this car had gone new ideas of weight, power, lines and speed—leaving their mark on every car built since then. Lycoming Motors, Duesenberg and Columbia Axle came into the growing fold.

Apparently cramped by the fact that he had a finger in only one form of transportation Cord turned to another field, Aviation. And suddenly that budding industry awoke one day to find that Cord controlled the Stimson Aircraft Company. He was making and selling planes much cheaper than his competitors. He was producing half the airplanes built in this country!

TO ACCOMMODATE this output he started the Century Airlines, hoping to parallel air routes already in use. But here he was stymied. Low as his mail-carrying rates were, he received no contracts from the Government. He sold out to American Airways. Mr. Cord had given up—apparently.

But not actually. As his price for the Century Airlines, American Airways gave him an interest in their company, which was holding more mail contracts than any other line. Then, differing on company policies, Cord went to the mat with the president of American Airways—and forced a gigantic financial battle which has brought him what is recognized to be the actual control of the company.

By this time transportation had become somewhat of a bee in his bonnet. Early in 1933 he and his associates gained control of the Checker Cab Manufacturing Company and its subsidiaries, giving him the ownership of the largest cab factory in the country.

Next in line were the railroads. In August, 1933, Cord bought 100,000 shares of Kansas City Southern Railway, or 20% of the outstanding stock. He could

Secrets of Success

FROM AUTO TINKERER TO BATTLESHIP BUILDER

(Continued from page 91)

now take the throttle of his own locomotive, if he so desired.

However, he wasn't through yet. Several months ago he turned his attention to ocean transportation. For $2,000,000 he became owner of the New York Shipbuilding Company. The day after he took control an order came in from the Navy Department—a $38,000,000 order for two cruisers and four destroyers! Cord had grabbed off the largest slice of the Navy's new contracts!

It is impossible to analyze the factors which make Errett Lobban Cord the unique success he is—and to hold up that success as an object lesson for young men. However, it is clear that his amazing career proves that there is no such thing as a "closed door" to success and advancement in modern business, regardless of how many contrary opinions you may hear today. Cord had no advantages, either in education or in wealth, that the average man does not have when he sets out to make his mark in the world. What he did have—and still has—is a driving desire to reach whatever goal he sets out for and an ability for concentrating every effort toward that ambition. In that direction everyone can learn from Errett Lobban Cord—and, as he has demonstrated, it is highly profitable to learn.

Cash Prizes

THIS department will give $5.00 for every true success story submitted by readers of Popular Science Monthly, and which is accepted for printing in this magazine.

Manuscripts will be judged on the individual merits of the case and circumstances involved. Only stories in which the author's success, or that of some one known to the author, has been gained by some method of educational guidance, fitness for the job, or application to the work will be considered. We are not looking for the "get-rich-quick" type of story.

Manuscripts must be confined to 500 words or less. They must be true and, if accepted, authors must be prepared to give us signed statements to the effect that they are true. Manuscripts submitted and printed become the property of this magazine, and we are not responsible for the return of rejected stories unless postage is provided for this purpose. Address contributions to Success Story Department, Popular Science Monthly, 381 4th Avenue, New York City.

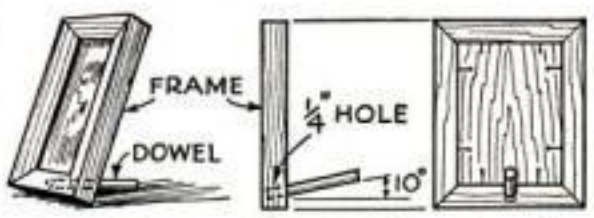
HOW TO STRENGTHEN AN OLD ROCKING CHAIR

TWO typical rocking-chair repairs are illustrated in the accompanying photograph. The broken backboard was strengthened by drilling holes through the lower pieces at *A* to allow slender screws to be driven home. Slow-setting casein glue was used to give plenty of time for drawing the joints together with the screws.

Method of fastening a split backboard and strengthening two slender arms of a chair

A piece was then fitted to the underside of the slender arms at *B* to receive two screws. The screw holes in the front of each arm were trued to a clean edge, and a plug was fitted in each to match the grain. In gluing up these parts, a certain amount of ingenuity is required to keep the hand screws or clamps from slipping, but it can be accomplished by using blocks as shown and, where necessary, placing one hand screw in a position where it will support another.—CHARLES A. KING.

DOWEL SERVES AS STAND FOR SMALL PICTURES



Any small picture frame can be stood up by inserting a dowel or two at the angle shown

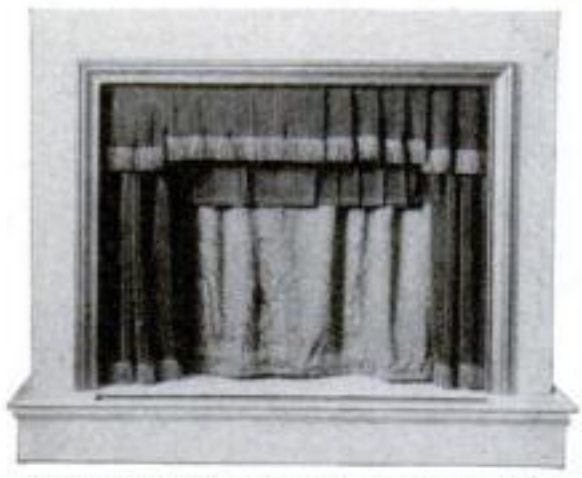
A QUICK and easy way to make a small framed picture or motto stand up on a desk or table is to insert one or two wooden dowels in the back as shown. For a very small frame, drill a ¼-in. hole into the back close to the lower edge in the center and at an angle of about 10 deg. Insert a piece of ¼-in. doweling about 1½ in. long. Stand the frame upright; then lean it backward until it rests upon this extension. For larger frames, use two dowels, one near each lower corner.—W. L. FAUROT.

SHELLAC MAKES SCUFFED RUG LIE FLATTER

IF A RUG scuffs up at a doorway, clean the back of the rug at this spot, coat it with shellac, spread a piece of waxed paper on the floor, and lay the shellacked rug on it. Weigh the place down with books or a large flat-bottomed pan, such as a roaster, filled with water. Leave until the gum has hardened, then peel off the waxed paper. The rug will stay as flat as when new.—E. S.

HOW TO BUILD A MINIATURE STAGE

(Continued from page 57)

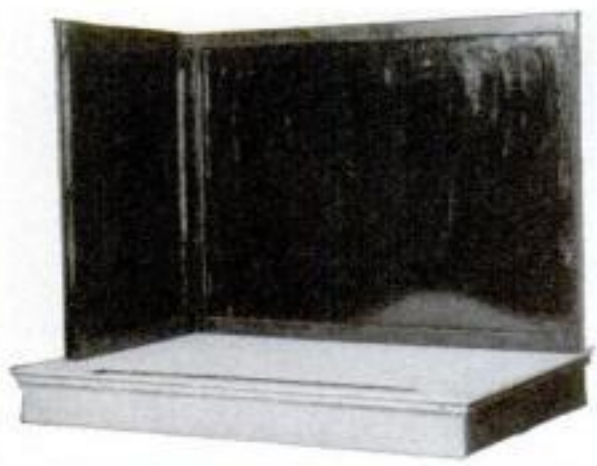


Stage with main draw curtain closed. The slot in the floor is to take the footlights

all material to size as given in the list, start work on the base. First lay out the material necessary and nail the different pieces together to form a frame as shown in the drawings. After the frame is finished, tack wall board about ¼ in. thick on the two ends. The wall board should be of the smooth, compressed fiber type, not plaster board or porous insulating board. Bring these end pieces up flush with the front and bottom edges of the frame, but let them project ¼ in. above the top and ¼ in. at the rear. Next fasten in place the front piece of board; this is long enough to cover the ends of the wall board on each end of the base. Fasten the floor down with tacks every 2 in. to keep the wall board from warping out of place. Finally the back of the base is covered with wall board. Each piece, when it is cut to size as listed, should be marked where it is to go. In this way no mistakes will be made. Picture molding may be nailed around the top of base on the front and ends as shown in the photographs.

The back of the stage is next made simply by assembling a frame as shown and covering it with wall board. The two ends are made in the same manner, only in this case the wall board extends over the front edge ¾ in. and the back edge ¼ in. as shown.

When the frame for the front has been completed, fasten the wall board into place, making



Base, back, and end. Nails dropped through pairs of screw eyes hold the frames together

sure that all parts are square; then saw out the stage opening, 28 in. high by 34 in. wide. Sandpaper the edges smooth. Picture molding may be used to frame this opening if desired.

In order to set up and take down the stage with ease, ¼-in. holes should be drilled through the bottom edge of the side frames and in the frame of the base to match. Set the pieces in their proper positions and drop long nails into the holes. At the top, the pieces can be held in place with loose pin hinges, or large nails may be dropped through screw eyes, as shown.

The frame for hanging the scenery is made by screwing together the three pieces marked O^1, O^2, and P on the drawings. To hold this frame in place, four small metal hangers R should be prepared as in the sketch. The scenery is held in place with wire hooks hanging from this frame.

When the stage is finished, paint the entire inside with *flat* black paint in order to stop all reflections. To finish the outside, paint it with flat paint in any color you desire. One should choose a color that will harmonize with the curtains and materials you intend to use. The molding around the stage opening may be painted pale gold; and if it is too bright, tone it down by brushing on a thin glaze composed of burnt umber and turpentine. Before this glaze has set, it should be removed from the raised parts of the trim by wiping with a clean cloth. The small amount left on will tone down the gold and will give an artistic effect.

In articles to follow, Mr. Hicks will tell how to make the curtains, scenery, and electrical equipment for this miniature stage.

List of Materials

WOOD (PREFERABLY WHITE PINE)

Mark	No. of Pieces	For	T.	W.	L.
A	4	Base	¾	1½	46
B	4	"	¾	1½	28½
C	2	"	¾	1½	22½
D	1	"	¾	1½	44½
E	4	"	¾	1½	2
F	4	Ends	¾	1½	20¼
G	4	"	¾	1½	35
H	2	Back	¾	1½	41½
I	2	"	¾	1½	35
J	1	Front	¾	1½	43
K	2	"	¾	1½	35
L	2	"	¾	1½	28
M	1	"	¾	1½	37
N	2	"	¾	1½	3
O	2	Scenery	¾	1½	20
P	1		1	1½	44¼

FIBER WALL BOARD

No. of Pieces	For	T.	W.	L.
1	Floor	¼	30	46
1	Front of base	¼	5¼	46½
2	Ends of base	¼	5¼	30¼
1	Back of base	¼	5¼	46
1	Front	¼	35	46½
1	Back	¼	35	46
2	Ends	¼	24¼	35

PICTURE MOLDING

2 pc. 2 in. wide by 30 in. and 1 pc. 2 in. by 38 in. for around stage opening.
2 pc. 2 in. wide by 32 in. and 1 pc. 2 in. by 48 in. for around stage base, front and two ends.

MISCELLANEOUS

4 pair 1 by 2 in. loose pin hinges (or screw eyes and nails) for holding frames together.
25 ft. of No. 18 wire (for hooks).
4 metal hangers made as shown in detail drawing.
Paint—½ pt. flat black, 1 pt. flat paint of any desired color; 1 oz. pale gold bronze.
Nails, tacks, and screws.

NOTE: Dimensions are given in inches. Prices will vary considerably in different localities, but the author paid $1.75 for wall board, $1.50 for white pine, 30 cents for picture molding, $1 for paint, 10 cents for wire, 20 cents for the hangers that support the frame above the stage, and 10 cents for nails and tacks.

Subscribers are requested to notify us of change of address four weeks in advance of the next publication date. Please be sure to give both old and new address.

How to Cut Bevels for Tables with Flaring Legs

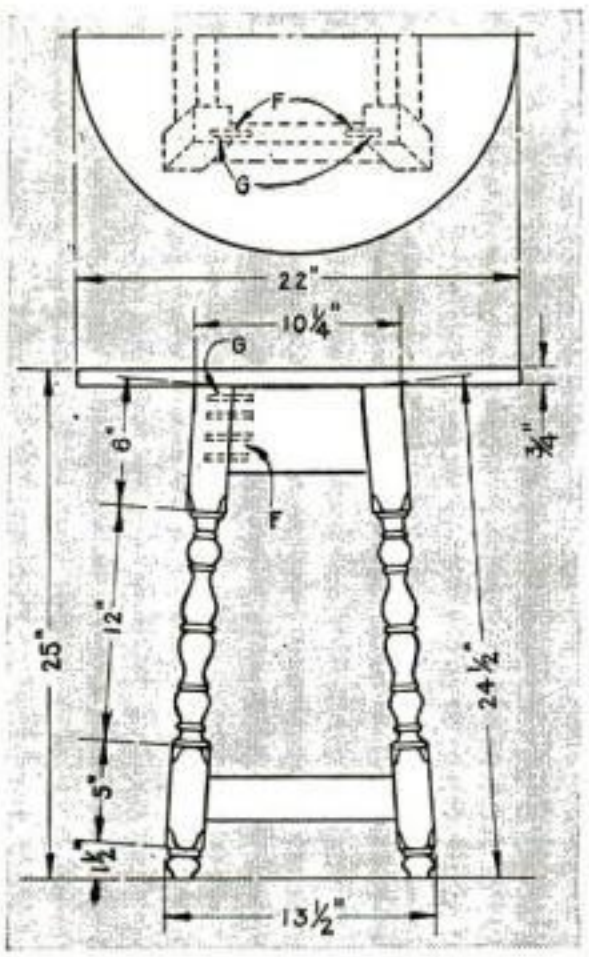
MANY home craftsmen at some time or other have admired a table or stool with flaring legs but have decided that the compound bevels necessary to give the legs the desired flare were a step beyond their skill. In this, as in many other cases, the apparent difficulties are exaggerated, as may be seen by studying the method of constructing the Colonial table illustrated.

A popular design for an occasional table.

Pine, maple, birch, red gum, or oak may be chosen for building the table; in fact, with the exception of the red gum, all of these woods were commonly used in the period during which this type of design originated.

The first step is to lay out the legs and turn them to shape. The foot rails, which are made next, should be cut about ⅛ in. wider than required to allow the top and bottom edges to be beveled so they will conform to the flare of the legs as at *A* in the illustration on the following page.

The cuts can be simplified by making a special bevel box on the same principle as a miter box. Lay out the right and left angles of the legs on both sides of the box as at *B*, and square across the top edges as at *C*. With a fine, sharp saw make accurate cuts to these lines. Make a piece about 2 in. wide and 2 ft.

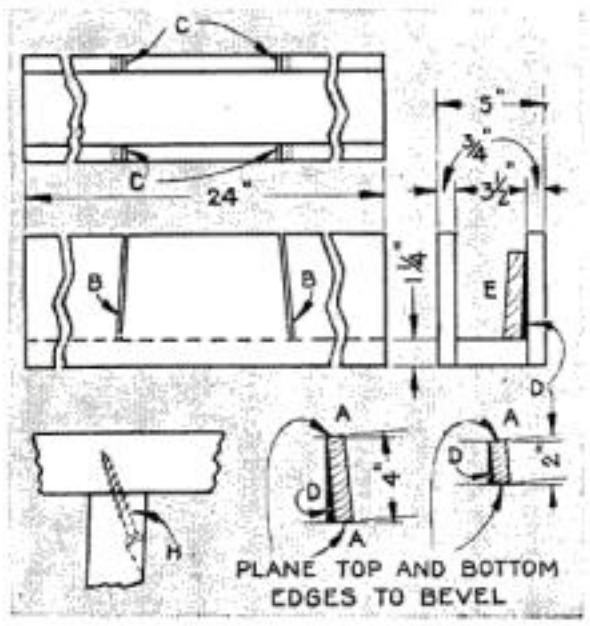


Dimensioned drawings of the table. The top view of the top rail assembly is shown dotted.

6 in. long to be placed as indicated at *D*, its bevel being such that when it is in place the rail will stand at the flare of the legs as shown at *E*. This angle block, which should be cut and planed very carefully, also may be used in cutting the foot rails.

It is obvious that if each rail is held in the box against piece *D* and sawed accurately as guided by the cuts *B*, the cut will have the correct bevels.

It is easier to keep the face of each rail and of its adjoining legs flush and straight across than to recess the rails. Place the legs face down on a flat surface



The bevel box and how it is used to cut the compound angles; and one way to fasten the top.

and fit the rail, face side down, against the same surface. If the leg and rail do not fit, a fine shaving or two may be taken from the side of the leg or from the end of the rail. In the latter case, be sure that the bevel of the rail is not changed.

In antique tables of this type, mortise and tenon joints were used, but for the sake of simplicity dowel joints may be substituted. Four ⅜-in. dowels should be fitted in each joint of the top rails, and two in the foot rails. Make sure that the holes in each rail are bored parallel to the face and edges of the rail as at *F* in the assembly drawing, and that each hole in the leg is bored parallel to the face and so as to conform to the flare as at *G*. This insures the straightness of the dowel holes.

Smooth the rails and assemble two pairs of legs with their corresponding rails, taking care that the rail and leg faces are in the correct relation to each other. When the glue has thoroughly hardened, fit the other rails in the other sides of the legs by the same method, and repeat the gluing process. The top of each leg should be cut down to conform to its adjoining top rails, and the top made, fitted, and fastened with dowels set into the rails and the top or with screws as at *H*.

Remove blemishes and superfluous glue and smooth and sandpaper all surfaces to make ready for finishing. The table may be finished in the natural wood by repeated oilings or given three coats of orange shellac. If preferred, the wood may be stained, given three coats of thin shellac, each rubbed with 4/0 sandpaper, and then polished with wax to obtain a finish.—C. A. K.

AUTOMOBILE TRADITIONS CHALLENGED

(Continued from page 15)

pressure was in the neighborhood of 5,000 percent greater than it was at forty miles an hour. Each additional mile of speed above forty is twice as hard to get as the preceding one because wind pressure increases with the square of the speed.

IN AN ordinary machine, making seventy miles an hour, eighty-five percent of the engine's power is required just to force the body through the air; only fifteen percent is needed to overcome rolling resistance, friction, and load. The average modern driver, hitting fifty miles an hour on the open highway, burns up seventy percent of his gasoline just to get through the air!

A perfectly streamlined car, according to Prof. Alexander Klemin, of the Guggenheim School of Aeronautics, in New York City, would cut fuel bills thirty percent at thirty miles an hour and would clip them in half at a sixty-mile pace. Such machines would consume less gasoline when traveling fifty miles an hour than a present-day car uses at thirty-five. Fifty miles on a gallon of gas is entirely possible with proper streamlining, tests conducted at the University of Michigan by Prof. W. E. Lay have indicated.

It is interesting to note that the finest streamlined sedan of 1933, according to Prof. Klemin, is actually only nine percent better in point of reducing wind resistance than a sedan of 1922. At sixty miles an hour, present-day automobiles produce virtually fifty percent as much resistance as they would if they pushed before them flat plates equal to their head-on area.

During the last decade, manufacturers have increased speeds by piling on horsepower. How vital streamlining is to higher speeds, with no increase in power, is illustrated by the records of the Schneider Cup Race. The winner of this aviation classic in 1915 traveled sixty miles an hour. In 1931, the winner touched 340 miles an hour. Had there been no advance in streamlining during the intervening years, aeronautical authorities calculate, the engine required to drive the first machine at the speed of the second would have had to have 29,200 horsepower. As a matter of fact, the 1931 seaplane carried an engine of 2,300 horsepower, approximately one-thirteenth the former figure. Streamlining and aerodynamic advance accounted for the difference.

AT LOW speeds, under forty miles an hour, wind resistance is not so important. But the average highway speed, with improved roads and better cars, is now placed at fifty miles an hour. By 1940, it is expected to be sixty-four miles an hour.

Consequently, in research laboratories, on proving grounds, in university workrooms, scientists, motor-car makers, and body builders have been busy grappling with the problems of streamlining. In their studies they have used curious instruments and special apparatus. They have driven at high speeds strange cars studded with pitot tubes which recorded air pressures at different points on the body. They added lines of brilliant dye to streams of water passing over wooden models to learn the points of most disturbance. They have placed full-sized machines on "rolling carpets" which showed the horsepower required to carry the cars over the ground when the wind pressure was nil.

In fact, many laboratories worked out special equipment of their own. At the University of Michigan, for example, "floating-envelope" trucks, machines with special bodies balanced so they moved on the chassis when wind resistance forced them back, recorded head-on pressures under road conditions.

Supplementing this research work have been numerous experimental cars embodying ultra-streamlining. In England, the curious steel beetle built by Sir Dennis Burney scooted along the roads at surprising speeds. In America, the Dymaxion of W. Starling Burgess, the Dream Car, exhibited at a recent Detroit show, and the Arrow Plane of Lyman Voelpel, have all pointed the way to the future.

Because automobiles run close to the ground instead of flying through the air, compromises and modifications of the ideal teardrop streamline shape are necessary. No one knows exactly how the ultimate streamlined car will look.

THAT it may carry fins at the rear like an airplane, is indicated by tests completed, not long ago, by the U. S. Bureau of Standards, in Washington, D. C. Fully streamlined cars, their wind tunnel experiments revealed, have a tendency to turn under certain wind conditions. Thus side winds might produce forces causing the car to skid. Vertical fins, such as are used on ultra-speed machines, may solve the difficulty.

Another problem, however, awaits the designers of streamlined cars. The curve of the auto's top, acting in the manner of the upper surface of an airplane's wing, may provide sufficient lift to interfere with the traction of the wheels. Sir Dennis Burney's English machine, for example, developed an estimated lift of 300 pounds when its speed reached a hundred miles an hour.

Outweighing these problems, are the obvious benefits of streamline constructon. The wider front will enable three people to sit comfortably in the forward seat. The curving body, replacing the straight lines of present cars, cuts out blind spots and increases visibility as much as twenty-five percent. In the Dream Car of the Detroit show, a periscope above the driver's seat afforded practically 100 percent visibility to the rear.

Closely connected with the streamlining experiments, have been recent investigations into the riding quality of motor cars. Using original apparatus—three directional accelerometers, steadiness meters, and vibrating platforms and seats—workers at Purdue University, Ind., under the direction of Professors H. M. Jacklin and G. J. Liddell, have analyzed riding comfort and the effects of vehicle vibration upon human beings.

A RECENT announcement of great importance in connection with increased riding comfort is the introduction on several makes of cars of independently mounted front wheels. In the cars of one manufacturer, by eliminating the front axle and attaching each front wheel directly to the chassis by means of its own spring, the wheels are permitted to rise and fall independently of each other and thus absorb road shock without transmitting it to other parts of the frame. The opinion expressed in automobile circles is that this and other improvements in the American cars of 1934 give them speed and riding comfort never before known.

To sum up. Since less power will be required to overcome air resistance in streamlined machines, there will be more power available at any speed for acceleration and hill climbing. Since the body curves farther out to the sides, it will be roomier and the windows will provide better vision. And, since smaller engines will be sufficient to reach speeds that require large-horsepower motors today, gasoline consumption will be greatly curtailed and economy of operation increased.

These are the goals toward which the wind-fighting automotive engineers are working in creating their new designs.

IF I WERE GETTING A PATENT . . .

(Continued from page 39)

times with a sledgehammer, and the door fell open!

The inventor had concentrated all his attention upon making a safe proof against explosives and burglar's tools. As a result, the internal locking mechanism was defective, consisting of a worm gear and wedge-shaped bolts. The jarring of the hammer-strokes had made the wedges slip back, allowing the door to fall open. Purchasers of the safes all over the country were in a panic. The company had to spend thousands of dollars sending experts around to insert a simple device in the locking mechanism which would prevent vibration from moving the bolts back—a thing the designer should have done in the first place. In the end, this slip of the inventor wrecked the concern.

BUILDING a working model of your invention and testing it in various ways will often help you iron bugs out of your innovation before you apply for a patent. It also prevents you from being accused of lack of diligence if you do not apply immediately for a patent. So, the fourth thing I would do if I were getting a patent would be to reduce my idea to practice as soon as possible.

Near the beginning of the present century, an odd genius was traveling around the middle west digging wells with a special apparatus he had patented. It enabled him to brick the sides from the top down instead of from the bottom up. It was a collapsible plate with a center opening through which the earth was removed. It was lowered little by little, and then folded up like an opera hat when the bottom of the well was reached.

While he was digging his wells, he thought of an idea for an improved chisel. The ordinary inventor would have applied at once for a patent. Instead, he started making models and adding every innovation or variation he could think of to his original idea. In the end, when he filed his application, it covered sixteen different forms of his invention, thus protecting him from having some other inventor get out a patent upon a change in his invention after it had gone through the patent office. The fact that he kept working on his idea showed he was not lacking in diligence.

According to patent law, if your idea is not published in a paper or magazine and is not placed in public use, you can spend a lifetime improving your idea, although you run the chance of someone else thinking of it in the meantime. But, if the idea is used in public or published, you must file your application within two years.

An unusual case hinged on this clause some years ago. In New Jersey, an inventor developed an improved paving block and laid some on a private toll bridge. Six years later, he applied for a patent. In subsequent litigation it was contended that the blocks had been in public use for more than two years. But the inventor contended that they were in experimental, not in public, use; that they could be tested properly only under actual traffic conditions and that it required the full six years to find out if they were superior to the ordinary blocks. In the end, the United States Supreme Court held his patent valid.

ON THE other hand, I remember a case in which a similar plea was upset unexpectedly. A client of mine was sued for infringement by the inventor of an improved steel frog for railroad tracks. Investigation revealed that exactly two years and seven months before the inventor had filed his application, he had sent one of the frogs to the Pennsylvania Railroad for test. The whole case, which involved a large amount of money, hung upon whether it required seven months or not to test the device. I called the expert who had been in charge of the tests for the railroad to the stand. He testified that the frog had been installed at the Broad Street Station in Philadelphia. Here a train a minute passed over it and the engineer said two weeks was ample time to test the merits of the frog. On this testimony, the inventor lost his case.

Every patent application consists of two parts: the description and the claims. The description describes the invention and tells how it works. The claims tell what is new about it. The claims are the heart of the patent. They tell the story of the invention and stake out the boundaries beyond which your patent does not give you protection. Consequently, attention should be given to the claims.

If the claims are too broad, the courts are likely to decide against the patent; if they are too narrow, you lose the protection to which you are entitled.

FOR instance, some years ago, an inventor obtained a patent upon a wire doormat. Soon afterwards, a manufacturer began putting on the market a mat that was an almost exact duplicate. The inventor sued for infringement. In court, the defendant pointed out that the claims of the patent stated that the mat was made "of warp and woof wires, the warp wires overlying the woof wires." He had simply reversed the process, putting the bottom wires on top and the top wires on the bottom, and had thus stayed outside the boundaries of the patent. The claims should have been worded "of wrap and woof wires, one set on top of the other," without saying which.

In the description, you give one preferred way of doing or constructing the thing you have invented; in the claims, you include alternate ways also. Thus, you may say that something is attached with a screw in your description, but in your claims you should word the statement so you can use a nail or a bolt as well.

The best patent of all is one covering a new, simple invention. But, usually, a simple invention is one of the hardest to patent. One reason is that the patent office examiner frequently holds it to be no invention at all. This brings me to the sixth common error I would try to avoid if I were getting a patent. I would fight a "lack of invention" decision by a patent office examiner.

Such ground for rejecting an application,—lack of invention,—is the easiest for the examiner to make and the hardest for the inventor to combat. Yet, often, the first official letter from the Patent Office says the submitted invention isn't an invention at all.

In conclusion, then: If I were getting a patent—

I would try to avoid the Six Slips of the Inexperienced Inventor by not being in too great a hurry when the search is made; by dating and having witnessed all notes and drawings as soon as possible; by going over all drawings for changes or errors; by checking over carefully all the claims; by reducing my idea to practice as soon as I was able; and finally, by refusing to give up the first time an examiner stated there was nothing new in my invention.

Fifty years' connection with inventors and the Patent Office has shown me that avoiding these half dozen common errors means avoiding much of the grief that beginners meet in their first encounter with the patent law.

CRACKED GAS FOR THE MODERN MOTORS

(Continued from page 56)

ignates anti-knocking qualities. They get it by comparing the running qualities of the gasoline with some known gasoline. A gasoline with a high octane rating will run under high pressure without knocking."

AS GUS talked, he ambled toward the repair shop door and beckoned to MacDonald to follow him. "I've got something in here along this same line," he said as he led the way to one corner of the shop.

"You know Dave Clemons? Well, this is his car. Brought it in here the other day to let me give the radiator the once over. During the conversation he happened to mention that his favorite brand of gas wasn't giving him the service it used to. Claimed it knocked.

"I suggested carbon. But he told me that he'd just had it cleaned. That gave me a hunch and I examined the gasket between the cylinder head and the block.

"My guess was right. The serviceman who did the job had substituted a gasket that was thinner than the one that was originally in the car. Naturally that reduced the cylinder head volume slightly. But even that small difference—and it wasn't over a tenth of an inch at the most—increased the compression enough to make 'regular' gas knock. With the 'premium' stuff, it works fine."

"Something like the mistake I made a couple of years ago," commented MacDonald as the two men strolled back to the garage office. "In putting in a new gas line, I got it too close to the exhaust and every hot day the motor would die. Had me puzzled until some one told me about vapor lock and I realized that when the motor reached a certain temperature, the gas boiled and the bubbles choked off the supply."

"Gasoline companies have licked that problem and they've licked winter starting, too," explained Gus. "Now they regulate their gasolines so they perform well under almost any natural temperatures. Sometimes they speak of this feature as 'climatic control.' Of course, the automobile companies have done their share, too, by designing the fuel supply more carefully."

"Well, the thing that gets me," confessed MacDonald, "is how the average car owner is supposed to know just what brand of gasoline is best for his car?"

"He doesn't have to know," concluded Gus. "Knock and gas mileage will soon tell him which is the best. Obviously, no one gasoline will meet the needs of all cars under all conditions. Be your own experimenter. Try several tanks of each of the good grade gasolines, both the regular and the premium. If you'll continue to use the one that gives you the smoothest, quietest, and peppiest performance, you can forget about octane ratings and compression ratios."

INCREASE IN SUNSPOTS WOULD KILL WORLD

IF A super-criminal wished to wipe out the earth, all he would have to do, according to Dr. R. M. Langer, of the California Institute of Technology, would be to cover the face of the sun with sunspots. The resulting increase in activity on our solar furnace would raise the temperature on the earth until life would be impossible and our planet would become as dead as the moon. If thermometers throughout the world, over a period of a year, indicated an average increase of only ten degrees, Dr. Langer points out, the rarefaction of the air around the earth would reduce the oxygen content below the point at which life is possible. The chance of this ever occuring is remote.

NEW DISCOVERIES SHOW ELECTRICITY GOVERNS OUR LIVES

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studied by S. D. Flora, State Meterorologist of Kansas. During dry seasons, he found, they cause severe damage to wheat and other grains, leaving long brown streaks across the fields.

But the greatest single factor in the war for the production of ions is the radioactive materials in the earth. They account for about one half of the ionization of the air. Such matter is widely distributed, producing ions in the pores of the earth from which they are withdrawn by the soil's respiration.

AGAINST these forces are arrayed two great enemies that continually consume or destroy the ions thus formed. One is a recombination of positive and negative ions into atoms or molecules. The other is the attachment of the ions to metal or liquid surfaces, that hold them as flies are held on sticky fly paper.

The outcome of this cosmic battle has greater personal significance than, until recently, we suspected. The latest tests have shown that the state of our health and spirits is closely linked to electricity in the air. Some mornings, for example, we get up feeling exhilirated; other mornings we get up feeling depressed. The difference, say experts in atmospheric electricity, is largely a difference of ions in the air.

As this is written, a ten-room house in Schenectady, N. Y., is the scene of an experiment that may have far-reaching consequences. General Electric engineers are testing a new type of air-conditioning apparatus that controls the elecricity in the air as well as the temperature and humidity. Special mechanisms, designed by Dr. Lewis R. Koller of the General Electric Research Laboratory, count and govern the number of electrified particles in the air while careful records show the effect upon the occupants of the laboratory-home.

The outcome of these experiments may throw light upon a puzzle that baffled eastern ventilating engineers not long ago. After a school was equipped with elaborate apparatus that washed, warmed, and humidified the air, the pupils contracted more colds than before! The answer to the riddle, some experts suggest, may lie in a difference in electrical particles in the air.

That such a difference does affect the human system has been proved definitely by a series of fascinating experiments carried on by Prof. F. Dessauer, of the University of Frankfort, Germany.

Among the Alps of Switzerland, a curious thing has been noticed. On certain peaks, mountain sickness, causing fever, headaches, and nausea which lasted for days, was common. On other peaks, equally high, it was rare. The only difference that scientists could discover in the two locations was in the amount of electricity in the atmosphere.

THIS started Dessauer on his study of the effect of atmospheric electricity upon the human body. He designed a curious ion incubator that would fill a room or a container with air that carried any given quantity of electrified particles. Whether these ions were positive or negative, he found, made all the difference in the world.

Positive ions, the researches demonstrated, produce fatigue, dizziness, headaches, a roaring in the ears, and sometimes nausea. Negative ions, on the other hand, produce a feeling of exhilaration.

Prof. Dessauer has applied these findings to the treatment of various diseases with remarkable success. He reports it has proved effective in asthma, rheumatism, high blood pressure, bronchitis, and arterial trouble.

In a study of 200 cases of high blood pressure, the records show eighty percent of the patients benefited from inhaling ionized air, the treatment extending over a period of several weeks. In cases of rheumatism, the electrified-air treatment was also followed by definite improvement.

Incidentally, the studies revealed a scientific basis for the twinges of rheumatic pain which foretell the coming of a storm. Just before a thunder shower, the scientist discovered, there is an unusual amount of positive electricity in the air near the ground.

Dessauer's apparatus pours as many as 20,000,000 ions into a cubic centimeter of air, a concentration exceeding that found anywhere in nature. One of these ion generators, driving a current of air over a block of heated magnesium oxide encircled by a metal collar charged with a 6,000-volt current, has been installed in the Beth Israel Hospital, in New York City. Under the direction of Dr. William Bierman, Head of the Department of Physical Therapy, promising results have been obtained. Another Dessauer apparatus is in use at the University of Wisconsin, at Madison.

At Harvard University, Dr. C. P. Yaglou, of the School of Public Health, has been carrying on a series of researches along the same line. He has found that in summer, negative ions have a cooling effect upon the body. He has also run across a scientific puzzle that has not yet been solved.

IN AN empty room, he found, the ion content is about the same as that out-of-doors. But the moment people enter the room, the count drops and remains at a lower level until they leave, when it climbs back to its former position. This cannot be accounted for by saying the ions are absorbed in breathing because the amount of air taken into the lungs is small in proportion to that contained in the room.

Where do the ions go? What makes them disappear and what makes them come back? Students of electricity are seeking the answers.

The further science plumbs this mystery, the closer is the link it finds between life and elecricity. The famous Cleveland, O., surgeon, Dr. George W. Crile, sums up his discoveries in the words: "Electricity keeps the flame of life burning in the cell." Dr. Charles H. Mayo, one of the noted surgical brothers of Rochester, Minn., adds that minute electrical charges are vital to the functioning of the brain. Dr. J. N. Washburne, of Syracuse University, N. Y., recently told a meeting of the American Association for the Advancement of Science that recent researches have led him to believe that learning is a process of arranging into different patterns the ions that are found in the nerve fibers of the brain.

From Russia comes news of a sensational application of ions to the work of food production. The Soviet government has awarded a $5,000 bonus to the Moscow scientist, Dr. M. Chizevitsky, for his discovery that ions can be employed to stimulate the growing of poultry. He found that when negative ions were added to the air in the coops, the poultry showed remarkable progress, rapidly increasing in weight, strength, and agility. The experiments were carried on with 1,000 chickens. As a result, ionized air is being applied to experiments with larger farm animals, a special laboratory having been turned over to the scientist by the government.

Plants, as well as animals, other tests have shown, respond *(Continued on page 101)*

NEW DISCOVERIES SHOW ELECTRICITY GOVERNS OUR LIVES

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to electricity acting in the air. When the Italian scientist, Dr. M. Mezadroli, carried on his experiments with high-frequency electric waves at Bologna, he found that onions subjected to the wave for thirty minutes a day matured fully ten days ahead of normal. Seeds, bombarded by the electric waves, often showed altered characteristics of heredity when they sprouted. In other tests, this scientist found that he could speed up the activity of silk-worms by placing them in the path of two-meter radio waves.

As scientists feel their way into this mysterious realm of high-frequency waves, they are meeting unexpected and bizarre experiences. At the General Electric laboratory, when Dr. Willis R. Whitney carried on recent experiments, he saw mice lose their tails and hibernating flies revive under the magic power of the short waves.

THE mouse was subjected to increasingly high-field intensities, which caused its body temperature to rise. In the end, without any apparent discomfort to the rodent, its tail shriveled up and dropped away! In another test, fruit flies hibernated in a glass tube when zero blasts passed over it. Then, with the freezing air still blowing over them, they were brought to activity simply by turning on the short radio waves. These warmed them internally. They had become their own heating stoves and were comfortable in spite of the intense cold around them!

Such revelations have made people wonder what effect the constant bombardment of radio waves will have on the human system. What will it do to us seventy years hence? Only within the past dozen years, have high-frequency sets been in operation. Now the trend is definitely toward short-wave transmission. Such electric waves, most potent of all in their effect upon muscles, nerves, and brains, are rapidly increasing in number. Sensational predictions have been made but as yet the evidence in their support is inconclusive.

Imagine cracking an egg on a plate and leaving it in the open air for a month without having it spoil or develop the least odor! That is the feat reported from Soest, Holland, where the scientist, Robert Pape, has been experimenting with the electric presentation of foodstuffs. The perishable produce is placed in an electromagnetic field. Applied in a certain manner, the Dutch worker reports, this is effective in preventing decay.

ANOTHER extraordinary bit of research, in which eggs played a part, is still puzzling the scientists. At the Ontario College of Education, in Canada, research workers prepared specially wired incubators in which the eggs were placed in different positions between negatively and positively charged plates. These eggs hatched in curious fashion. A control group, which has not been subjected to the electrical influence, hatched first. Thirty-six hours later, the eggs which had been placed at right angles to the plates broke open and fully five days late came those which were laid parallel to the plates. Why did the difference in position of the eggs in relation to the electric plates delay the hatching? Nobody knows. The scientists are trying to find out.

Passing over the earth, unfelt except by delicate instruments, are lines of magnetic force flowing between the north magnetic pole, located far inland on the edge of the polar ocean, and the south magnetic pole, lying a thousand miles north of the South Pole on the high, *(Continued on page 102)*

Driver Workshop with Seth Parker Expedition

Phillips Lord whom you've heard on your radio as Seth Parker and the Country Doctor is fulfilling a boyhood dream to sail his own ship around the world. His expedition will visit little known countries of the African coast, the tiny, unfrequented South Sea Isles, odd and interesting parts of India, Siam and other unusual places. Conducting the cruise solely for the enjoyment and romance that can be derived, Seth Parker, for years a Driver enthusiast, has installed a complete Driver woodworking shop in the hold of his boat. He fully understands the vast amount of real pleasure and entertainment that can be secured on this voyage from a shop equipped with such machines as the Driver "500" Bench Saw shown below.

NEW DISCOVERIES SHOW ELECTRICITY GOVERNS OUR LIVES

(Continued from page 101)

ice-covered plateau at the lower hub of the Earth. These lines of force, running through the air and in the ground, shift according to little-understood laws. For twenty years, the Carnegie, a ship without a nail or bit of steel on board, sailed the seas gathering data on these magnetic lines, a phenomenon closely linked to electricity in the air. In 1929, this vessel, the only one of its kind, was destroyed in a gasoline explosion in western Samoa.

It is now known that magnetism, electricity, volcanoes, and earthquakes are linked in some mysterious way. When a volcano erupts, for instance, compass needles which are far out of range of the earth vibrations are shaken with magnetic tremors. Again after an eruption, when the lava is cooling, it becomes magnetized either positively or negatively according to the direction of the earth's magnetic field at the time. By studying old lava beds, Dr. A. J. Fleming, of the Carnegie Institution, suggests, scientists may be able to learn new facts about the magnetic history of the earth.

THE latest method of forecasting earthquakes, which is being tried in Chile where small quakes occur almost weekly, employs disturbances in the earth's magnetism as a sign of an approaching tremor. At the Salto Weather Observatory, in that country, it was noted that severe quakes were always preceded by magnetic storms in the region. Sensitive instruments at the observatory now register minute-to-minute variations in terrestrial magnetism and, on these records, earthquake predictions are being broadcast with the regular weather reports.

In the eastern part of the United States, one of the most curious uses of electricity in the air was recently reported. Mushroom growers found that after an electrical storm the fungi grew most rapidly. Ozone in the air, a product of lightning flashes, was believed to be the cause. So now, when they want to hurry their crops for market, they turn on machines which discharge static electricity into the air and produce conditions similar to those that follow lightning.

That lightning may descend from the heavens to the earth along a path prepared by cosmic rays is the suggestion of John Thadberg, a Stockholm, Sweden, physicist. According to his theory, which was recently presented in a British scientific journal, the rays ionize the air along the irregular path, the electrified particles acting as ferry-boats to carry the bolt across the gap.

Such flashes from the sky add some 100,000,000 tons of nitrogen to the soil each year, K. B. McEachron, lightning engineer of the General Electric Company, estimates. In passing through the air, which is approximately four-fifths nitrogen, the discharges fix in the ground large quantities of this chemical so vital to plant growth.

FOR a number of years, science has received skeptically tales of lightning that rolled out of the sky in balls. A few weeks ago, however, two scientists in Nebraska not only witnessed such a display but obtained excellent photographs of it. They are Prof. J. C. Jensen, of Nebraska Wesleyan University, Lincoln, and George Raveling, U. S. Weather Bureau observer in the same state. Both saw the ball lightning during violent storms that were almost tornadoes. According to Raveling's description, a fiery stream poured from the sides of a boiling, dust-laden cloud, like water pouring from a sieve, breaking into spheres of irregular shape as it descended.

In its various forms, electricity, drifting or working in the air around us, is rapidly assuming a more important place in science's picture of nature. Spectacular advances have been made recently in its study. It still remains, however, a realm of infinite possibilities and many mysteries.

ELECTROPLATING IN YOUR OWN LABORATORY

(Continued from page 49)

the batteryless method.

Novel coatings of cobalt can be given copper and brass surfaces with a solution made of ten grams each of cobalt sulphate and ammonium chloride dissolved in 500 cubic centimeters of water.

To copper plate iron by this ingenious method place the iron articles in the zinc basket and immerse them in a solution comprised of seventy grams of cream of tartar, twenty-five grams of sodium hydroxide, eighteen grams of copper sulphate, and 500 cubic centimeters of water. In making up the solution, dissolve the cream of tartar in one third of the (hot) water and the sodium hydroxide in another third. The powdered copper sulphate is dissolved in the remaining one third and the three solutions mixed.

Objects of brass and copper can be cadmium plated by a simple rubbing-on process. A cloth is moistened with a solution made by dissolving one gram of cadmium chloride in twenty cubic centimeters of water, dipped in zinc dust (finely powdered zinc), and then rubbed on the surface to be plated. In this particular case, the powdered zinc takes the place of the zinc basket or tray.

If you have no scales that can be used for measuring out these chemicals, you can obtain the approximate weights by figuring that a level teaspoon of any powdered substance weighs roughly about four grams. For the volume measurement, an average water glass can be considered as containing approximately 180 cubic centimeters and one ounce (fluid) as being equal to thirty cubic centimeters.

In plating without a battery, the solutions can be used again and again. However, the zinc basket or tray must be cleaned after every period of use to keep it free of the whitish coating that tends to form. To get the most out of the solutions, be sure to turn the articles being plated now and then during the plating process.

TO RECEIVE ATTENTION, every inquiry relating to articles published in POPULAR SCIENCE MONTHLY *must be accompanied by a self-addressed, stamped envelope. It is important that the questions be brief and to the point. Mention the article, the page, and the issue of the magazine to which reference is being made.*

FACTS ABOUT WATER NOW SAVE MILLIONS

(Continued from page 35)

they placed in trenches that bounded the sides of a paved rectangle, upon which was a travelling derrick equipped with a weighing apparatus. The trees were lifted and weighed, the soil was irrigated to field capacity, and the weights were again taken. The soil surfaces were then covered over to prevent any evaporation whatever, and the trees were permitted to function as though they were in an orchard.

PERIODICAL weighings showed just how much water was being used by each tree, and it was soon noted that the consumption rate bore no relation to the amount available, but was the same, other things being equal, whether the moisture content was high or low. They were seldom equal, however, so the rate varied greatly from day to day and was much faster, in fact, when the water was half exhausted, than at the beginning.

Since the trees were considerably larger by this time, this suggested to the experimenters that perhaps the root development had something to do with it. But it was then observed that a rise in the temperature caused a rise in the consumption of water, so the root hypothesis was eliminated. Anyhow, there was that day-to-day variation to be explained.

To test this more accurately, a new device was brought into play. It was constructed somewhat like a child's see-saw, with one end counterbalanced against the weight of a tank-enclosed tree at the other. From one end, a rod went up through a platform and held a pencil against a recording device, so that the slightest change in the position of the balance would be automatically graphed, together with the exact time of its occurrence.

It was soon found that the tree's self-written report would have served admirably as a weather record. Hot sun or dry winds brought an immediate rise in the consumption rate, as shown by the moving graph. Cool and overcast periods, or a high degree of humidity, caused the rate to fall off, sometimes to zero. But the scale on which all this took place steadily increased.

THEN one of the experimenters stripped half the leaves off the tree, and the consumption rate, with all its variations, was promptly cut in half.

It was clear, then, that the determining factor was the rate at which the moisture could evaporate from the leaves.

These, it was found, functioned like tiny drying pans offering the tree's moisture to the sun. The amount of water thus evaporated depended upon the leaf area of the tree. Variations in the rate at which moisture was extracted from the soil were produced by weather conditions which promoted or retarded evaporation from the leaves.

It is the leaves, therefore, that determine the size of the tree. By exposing their own moisture to evaporation, they make room for new supplies of it to be brought to them from the roots, via the tree, by capillary action; and since it is the chemical content in this moisture that nourishes the tree, its growth is directly affected by the rate at which this evaporation takes place.

At this point, the experimenters ran upon one of the most curious of the many discoveries they made. Seeking to determine the exact "wilting point," at which the tree began to die from insufficient water, they gradually reduced the amount of moisture within the steel containers. To their surprise, they found that even after the leaves had begun to wilt, the scales indicated that nearly a third of the original water supply still remained in the soil. *(Continued on page 104)*

Facts About Water Now Save Millions

(Continued from page 103)

Further examination revealed the soil to be actually moist—yet the tree was dying from lack of moisture!

What was the explanation of this mystery? Only after the scientists had made several laboratory experiments, including careful tests with a centrifugal machine, to determine just how tightly this residual moisture was held by the soil, was the secret disclosed.

Just as a certain amount of moisture, up to field capacity, is held so tightly as to resist the pull of gravity, so a part of this is held even more tightly, and resists even the capillary pull of the roots.

This permanent wilting percentage, as it is called, bears a fixed ratio in any soil to the latter's field capacity. But it varies widely in different types of soil, ranging from twenty-five percent of field capacity in one to seventy-five percent in another, depending upon the soil's composition. Some of the clays, for example, which have a high field capacity, also have a high wilting percentage, owing to the tightness with which their closely-packed particles cling to the moisture. Some sands, on the other hand, owing to the looseness of their composition, not only hold less water than the clays but give it up more readily to the roots.

THE amount of moisture in a given soil in excess of the permanent wilting percentage and up to the field capacity is called the readily available moisture. It is this latter figure that is most important. It alone tells how much water a tree can get out of a given irrigation. As the residue remains in the ground indefinitely and never has to be replaced, knowledge of the wilting percentage and the field capacity of a soil enables the irrigation farmer to determine scientifically just how much water he must supply.

Another discovery made by the experimenters shows him how to supply this water most effectively. The belief has been almost universally held that water put anywhere near the roots will find its way to them by capillary action. But the tests made with the furrows showed that this was by no means true.

The lateral movement of water, was not nearly so great as had been presumed, and was due solely to gravity. If water is put on soil faster than it can permeate it, there is nothing for some of it to do but go sidewise; but as soon as this surplus has drained away practically all lateral movement stops.

A quantity of water, they found, that will wet the soil to a depth of six feet, will spread laterally only two and a half feet from the center of each furrow. So if the furrows are five feet apart their moisture areas will just meet. If they are six feet apart, there will be a foot-wide strip of dry soil between them.

SPACING the furrows so the lateral movement of the water just closes the gap between, without any overlapping, is an important phase of successful irrigation farming. Millions of gallons of dearly bought water are now being thrown away annually because this discovery of science is not in universal application.

By withholding irrigation, many farmers have believed that they could force a tree to send its roots down to new low levels after subterranean water. The work of the investigators showed that so far as the movement of the roots is concerned, this theory is correct. In a fascinating series of tests, they demonstrated the uncanny ability of various roots to go after water wherever it lay.

First, they separated two plots of soil with a waxed partition that was impervious to moisture. One plot they left dry. Then in the other, they grew small plants. The roots of the plants reached the partition and stopped. Then they wetted the other plot. The roots promptly bored their way through the partition!

Likewise, roots will go down seven, eight, and even more feet after water in the ground. But the scientists learned, that getting this water up to the tree is another matter. By means of auto-irrigators—porous containers connected by pipe lines with the surface—the men were able to irrigate the seventh-foot level, while permitting the upper six feet to go dry. Although they poured enough water in the pipes to support a couple of trees, the experimental one wilted. The roots were unable to raise the water fast enough from that depth to keep pace with the tree's needs.

The average tree in an orchard, they found by painstakingly removing the dirt from around the base, sends its roots down five or six feet. The bulk of them, however, are bunched in the second, third and fourth feet.

THE old-time theory, supported by the physics text-books of half a century ago, was that there was a considerable capillary movement of water through soil, and that as fast as water evaporated from the surface, new moisture rose from below to take its place until the entire sub-soil had dried out. To break up these capillary routes and put a moisture-proof cover on the ground, farmers are still spending millions of dollars a year in disking, cultivating, and mulching their orchards.

Having already discovered that the capillary action was much less than had been supposed the investigators now tested this age-old belief with the tanks and the weighing derrick. They found that a tank of unplanted soil watered to field capacity, would lose moisture by evaporation rapidly immediately after irrigation, less rapidly for about a week, and then at a rate so slow as to be barely perceptible. At the end of eighty days, the soil had lost only twice as much moisture as in the first week; and when the soil itself was examined, it was found that it had lost no moisture at all from below the eight-inch level. And of these eight inches it was only the upper four that were completely dry.

Chimneys Blow Smoke Rings

To add an unusual touch to these Orvieto, Italy, chimneys, they were constructed on spiral lines so that the smoke comes out of them in graceful curves and rings.

The fact that the top eight inches will eventually dry out is of no consequence to the farmer, since his roots are all below that level. So except for shallow-rooted plants, all the time and money that is spent on cultivation, so far as it is designed to prevent evaporation, is utterly thrown away!

WEEDS and cover crops, moreover, were found to be accomplishing just the reverse of their intended purpose. For they themselves were busily extracting from the soil the moisture that could have been used by the trees.

In one astonishing demonstration, the weighing derrick showed that four young morning glories used as much moisture in a given time as one tree, and as much in four or five days as would have been lost through evaporation in as many years!

After the experiments were completed at the test farm at Davis, the discoveries were applied to orchards and vineyards, orange groves and cotton plantations in nineteen counties in California. Under the expert supervision of the university farm advisors, the owners put irrigation and cultivation on a scientific basis.

Immediately, it was discovered that many farmers had been using nearly twice as much water as was necessary, putting on from sixteen to twenty inches per acre where scientific tests showed only ten inches were needed. Since they were paying from seventy cents to a dollar an acre inch, the reduction in cost ranged from $4.20 to $10.00 an acre. Thus on a hundred-acre farm, from $420 to $1,000 was being thrown away with each irrigation—and sometimes there were as many as three a year!

But the waste didn't end there. In addition, it was found that the excess water was actually cutting down the size of the crop. In one orange-growing county, for example, when the soil received less than twenty-four inches a year, the trees yielded ninety-one boxes per acre. If it received between twenty-four and thirty-one, the yield jumped to 155 boxes. But if it passed thirty-one inches, the yield dropped back to 108 boxes.

Besides costing the farmer anywhere from four to thirty dollars an acre each year, the excess water was robbing him of about forty-seven boxes of oranges—approximately one-third of his potential crop. The reason for this reduction, the investigators found, was that the excess water fills the pore spaces in the soil, displacing oxygen which the roots require.

Several years have passed since the first field applications of the discoveries. Thus, sufficient time has elapsed to show the immense practical value of the researches. Consider a few impressive figures from last year:

In Fresno County, alone, the saving on irrigation was a dollar an acre, a total of $275,000. In El Dorado County, it was $5 an acre and in Butte County it ran as high as $10 an acre. Besides this, there was a big cut in cultivation costs. In many of the counties, it was the custom previously to cultivate as many as twelve times a season. This has now been reduced to six and in some cases even to two.

In Mendocino County, to take a typical example, the combined irrigation and cultivation costs used to run to about $30 an acre. Now, it has been cut to $6. The total saving in the nineteen counties where the findings of Veihmeyer and Hendrickson have been put into practice was $4,500,000 during the twelve months of 1932. This figure is expected to mount to more than $10,000,000 when all irrigation farming counties in California adopt the same methods. And these methods are equally applicable to the sixteen other states where irrigation farming is practiced.

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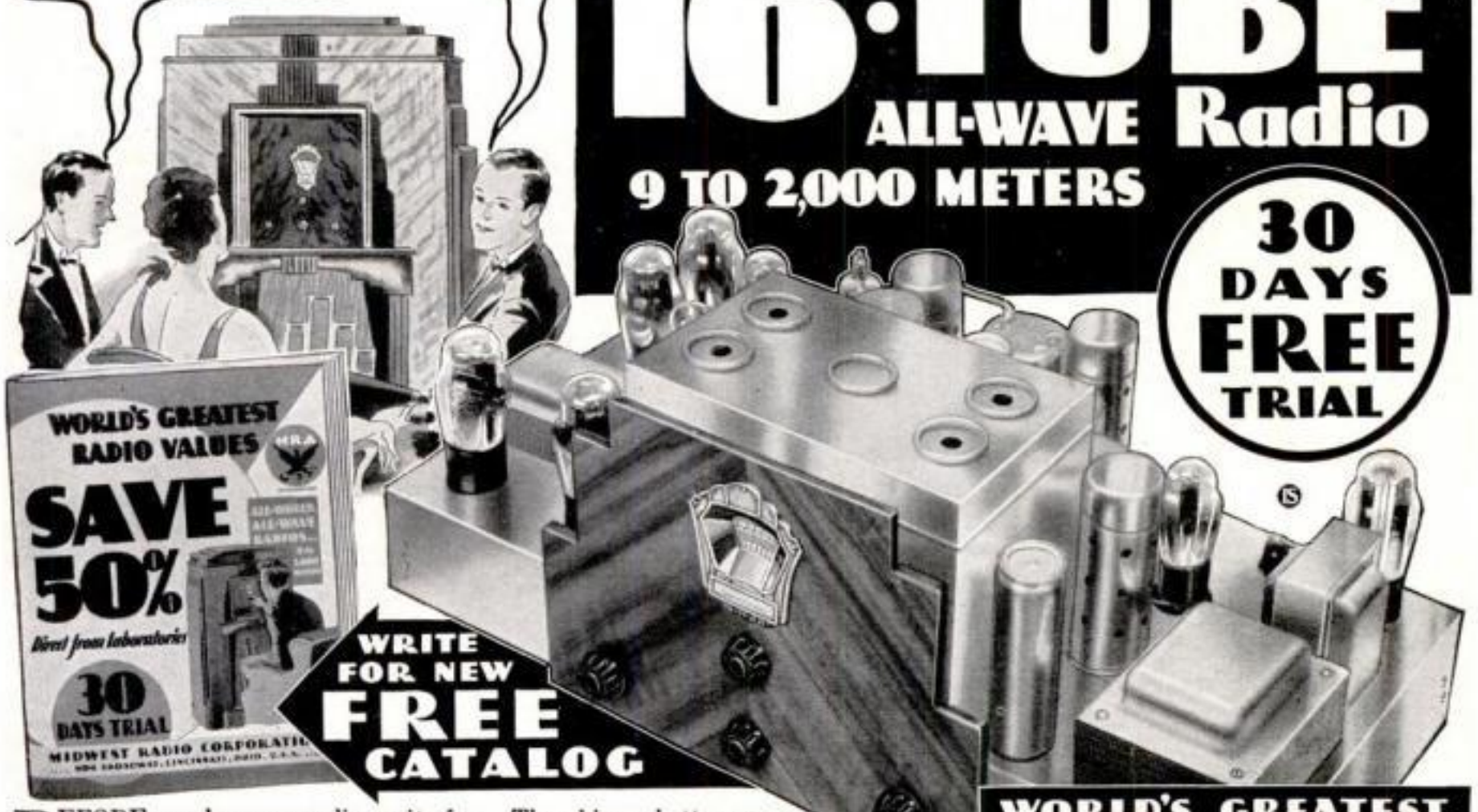

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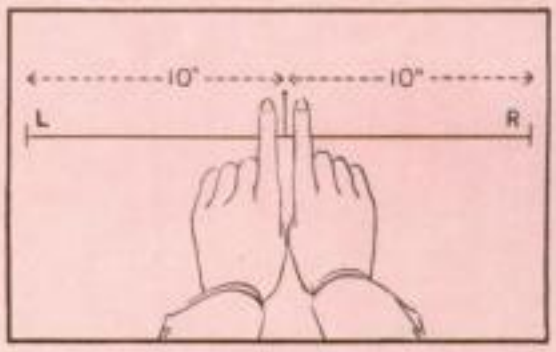

Draw a line 20 inches long on the edge of a newspaper. Stick a straight pin in the exact center. Place a forefinger on either side of the pin. Close your eyes...try to measure off quickly the distances by moving both hands at the same time. Have a watcher stop you when you reach the edge. See if both your fingers have moved the same distance. Most people try this at least six times before both hands come out evenly.

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